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Yoo et al.

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(45) **Date of Patent: Nov. 23, 2021**

(54) **ELECTRONIC DEVICE INCLUDING ANTENNA MODULE**

(71) Applicant: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(72) Inventors: **Sungcheol Yoo**, Suwon-si (KR); **Chihwei Lee**, Suwon-si (KR); **Jungmin Park**, Suwon-si (KR); **Chonghwa Seo**, Suwon-si (KR); **Jongwon Lee**, Suwon-si (KR)

(73) Assignee: **Samsung Electronics Co., Ltd.**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 52 days.

(21) Appl. No.: **16/924,863**

(22) Filed: **Jul. 9, 2020**

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(30) **Foreign Application Priority Data**

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Mar. 4, 2020 (KR) 10-2020-0027269

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H04M 1/00 (2006.01)
H01Q 1/24 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/38*** (2013.01); ***H01Q 7/00*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/38; H01Q 7/00; H01Q 1/241; H01Q 9/04; H01Q 13/10; H01Q 19/005; H01Q 21/00; H01Q 5/48
See application file for complete search history.

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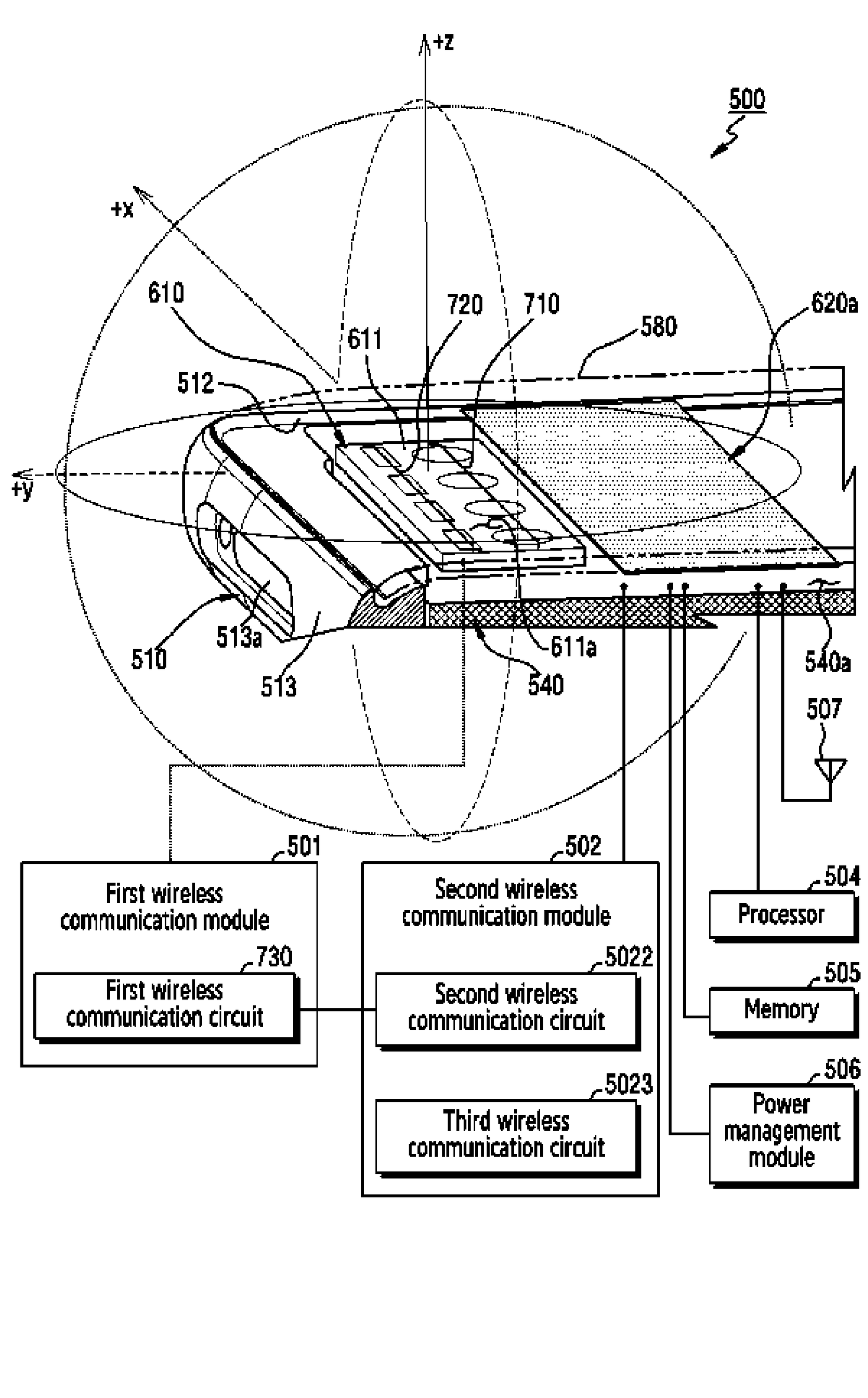
Primary Examiner — Nhan T Le
(74) *Attorney, Agent, or Firm* — Jefferson IP Law, LLP

(57) **ABSTRACT**

A portable communication device is provided. The portable communication device includes a display defining a front surface of the portable communication device, a plate defining a rear surface of the portable communication device and including a nonconductive material, the plate including a first surface facing an outside of the portable communication device and a second surface facing an inside of the portable communication device, a first antenna module attached to a first area of the second surface or disposed adjacent to the first area, a second antenna module attached to a second area of the second surface or disposed adjacent to the second area, and a conductive member disposed in or attached to a third area between the first area and the second area, wherein the conductive member at least partially interrupts some electric waves, among electric waves radiated from the first antenna module, that travel towards the second antenna module through the plate.

17 Claims, 33 Drawing Sheets



(51) **Int. Cl.**
H01Q 1/38 (2006.01)
H01Q 7/00 (2006.01)

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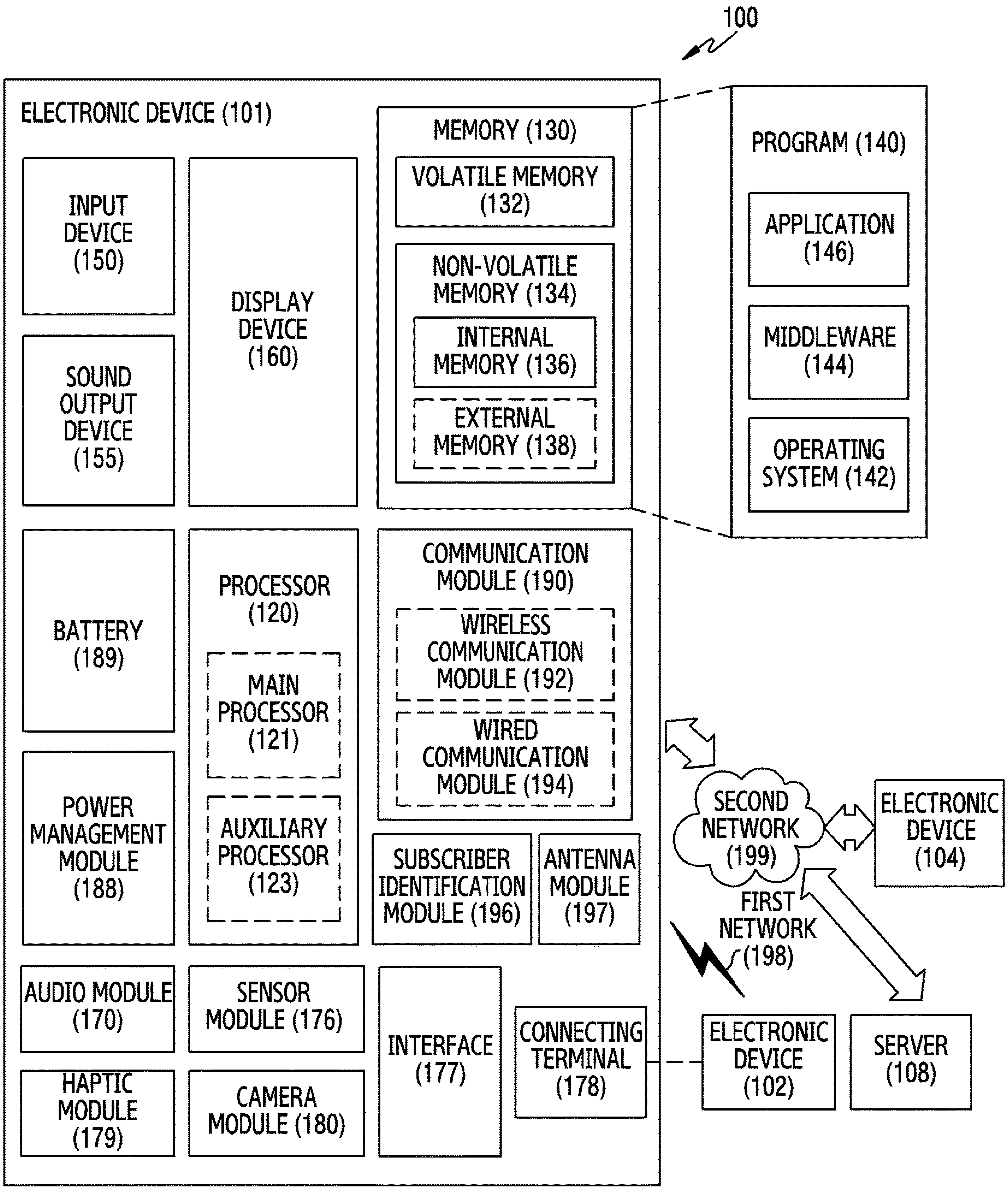

100
ELECTRONIC DEVICE (101)
INPUT DEVICE (150)
SOUND OUTPUT DEVICE (155)
DISPLAY DEVICE (160)
MEMORY (130)
VOLATILE MEMORY (132)
NON-VOLATILE MEMORY (134)
INTERNAL MEMORY (136)
EXTERNAL MEMORY (138)
PROGRAM (140)
APPLICATION (146)
MIDDLEWARE (144)
OPERATING SYSTEM (142)
BATTERY (189)
PROCESSOR (120)
MAIN PROCESSOR (121)
AUXILIARY PROCESSOR (123)
COMMUNICATION MODULE (190)
WIRELESS COMMUNICATION MODULE (192)
WIRED COMMUNICATION MODULE (194)
POWER MANAGEMENT MODULE (188)
SUBSCRIBER IDENTIFICATION MODULE (196)
ANTENNA MODULE (197)
SECOND NETWORK (199)
ELECTRONIC DEVICE (104)
FIRST NETWORK (198)
AUDIO MODULE (170)
SENSOR MODULE (176)
INTERFACE (177)
CONNECTING TERMINAL (178)
ELECTRONIC DEVICE (102)
SERVER (108)
HAPTIC MODULE (179)
CAMERA MODULE (180)

FIG.1

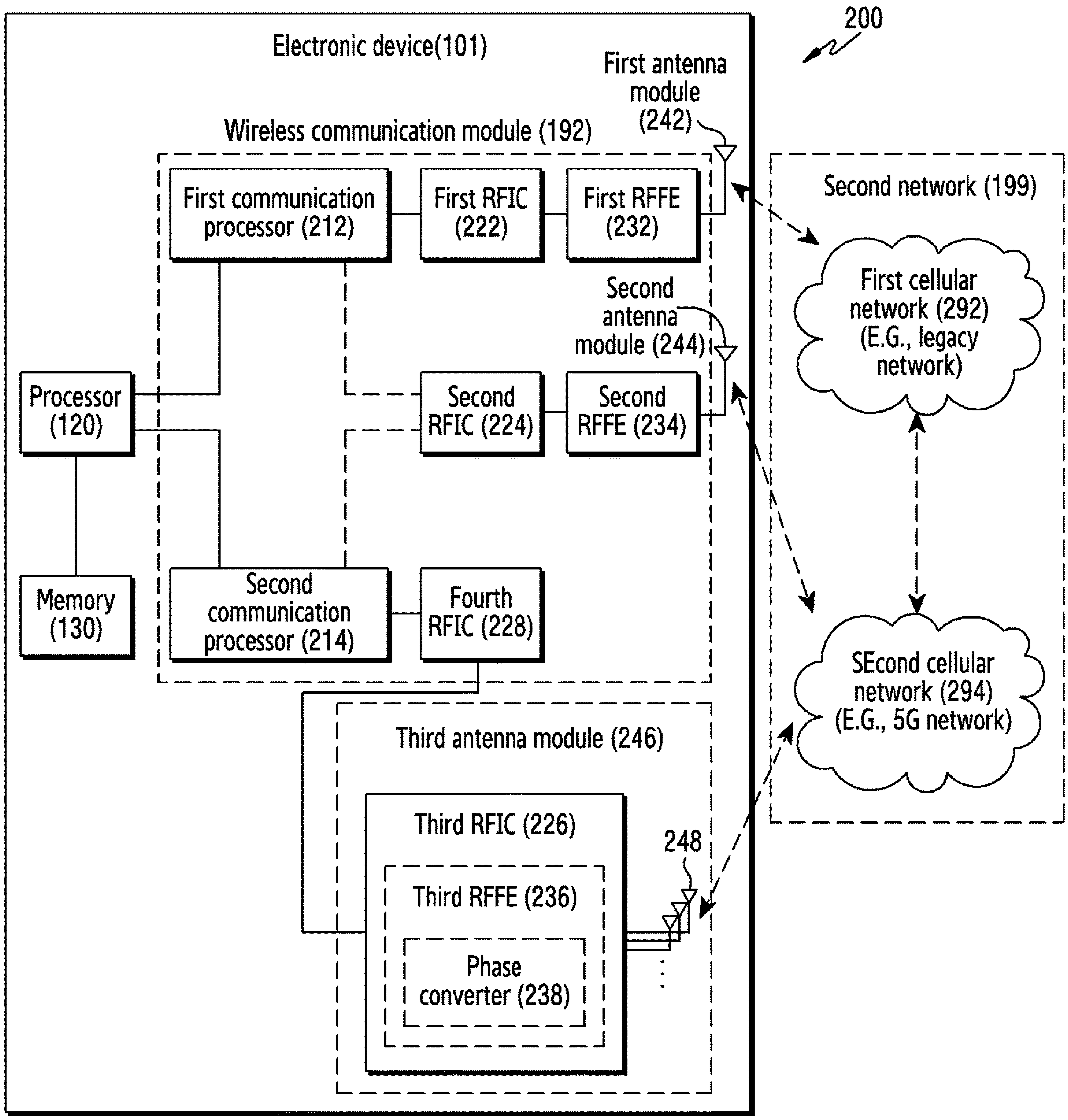

200
Electronic device(101)
First antenna module (242)
Wireless communication module (192)
First communication processor (212)
First RFIC (222)
First RFFE (232)
Second network (199)
First cellular network (292) (E.G., legacy network)
Second antenna module (244)
Processor (120)
Second RFIC (224)
Second RFFE (234)
Memory (130)
Second communication processor (214)
Fourth RFIC (228)
SEcond cellular network (294) (E.G., 5G network)
Third antenna module (246)
Third RFIC (226)
248
Third RFFE (236)
Phase converter (238)

FIG.2

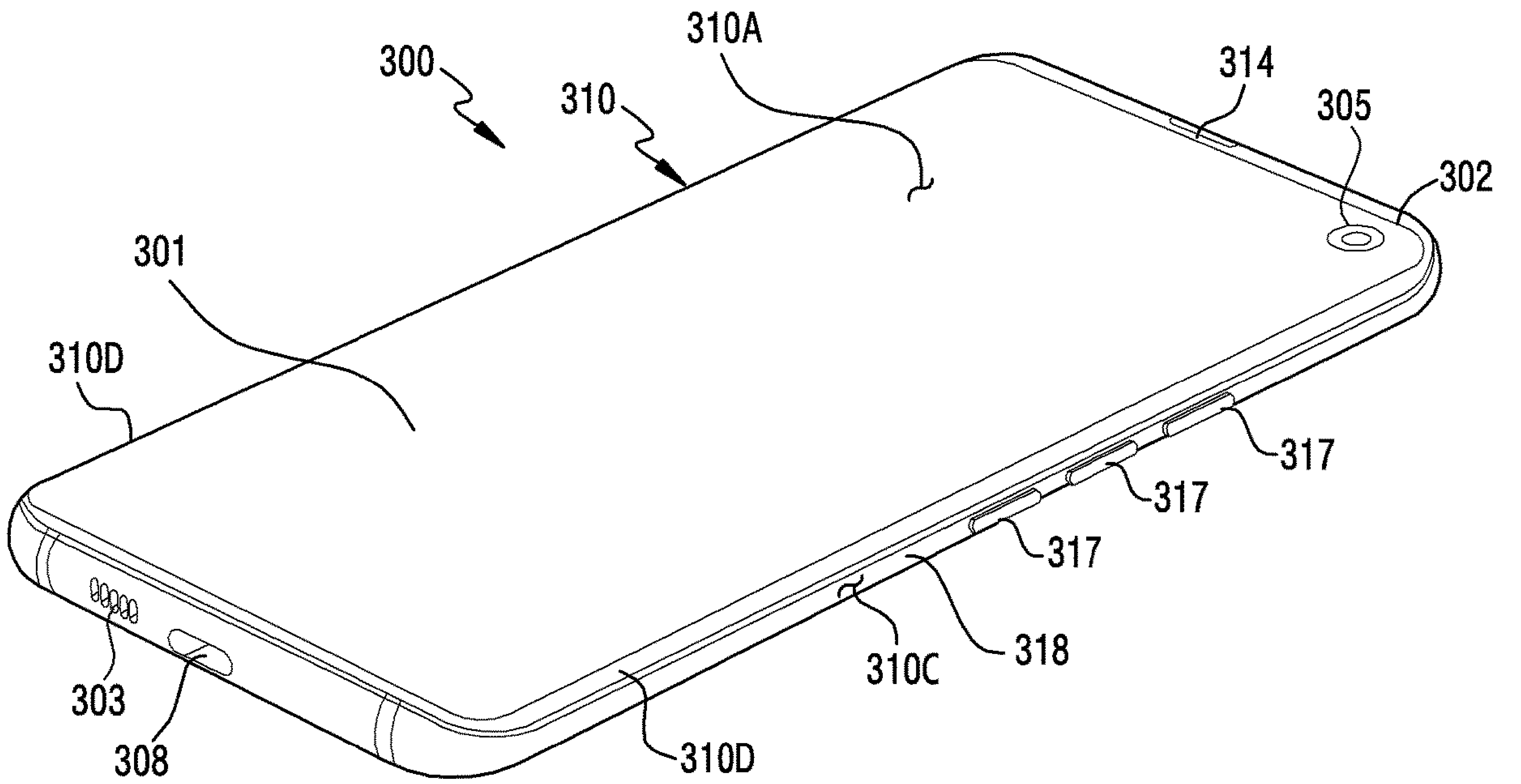

300
310A
310
314
305
302
301
310D
317
317
317
318
310C
303
308
310D

FIG.3A

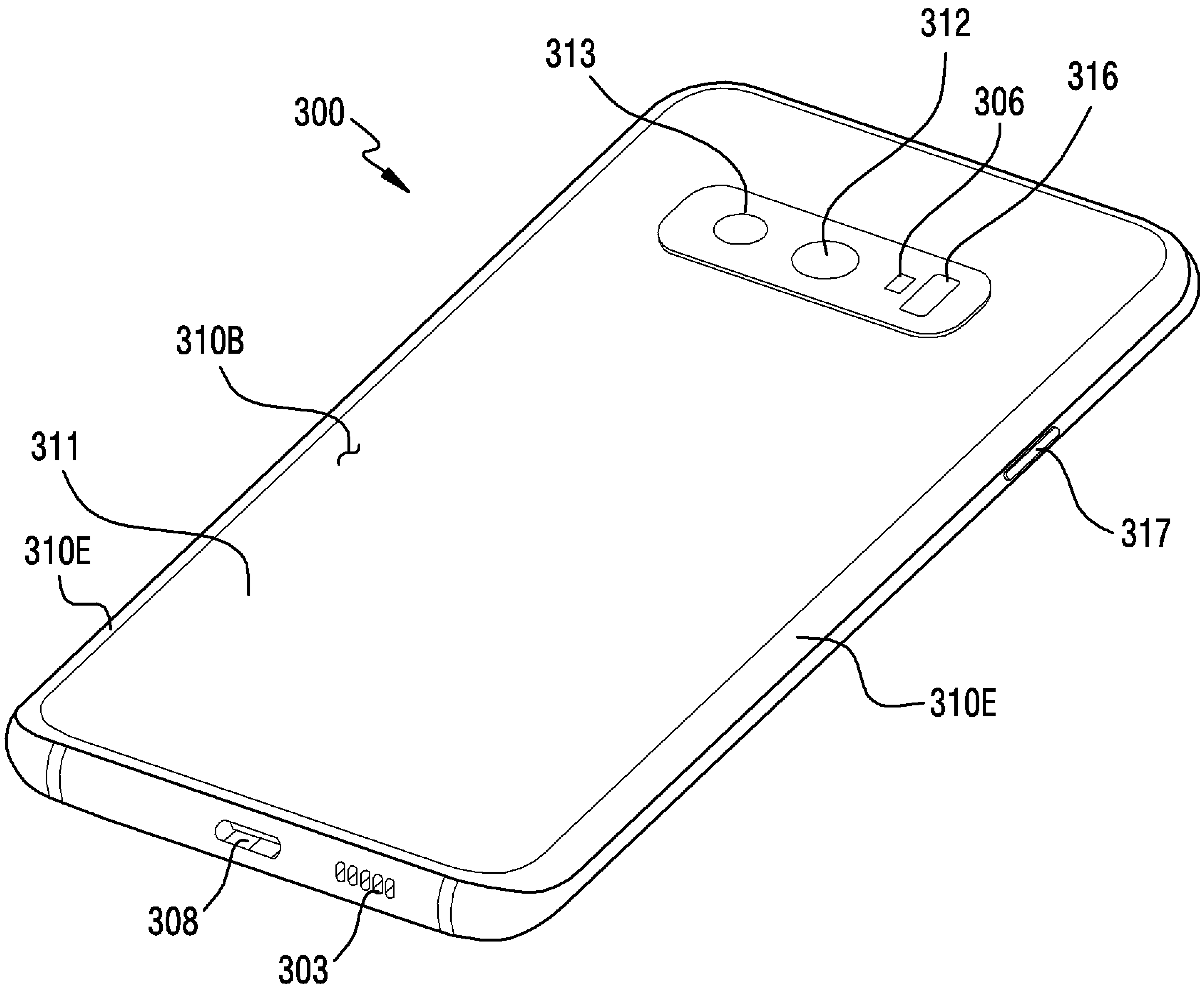


FIG.3B

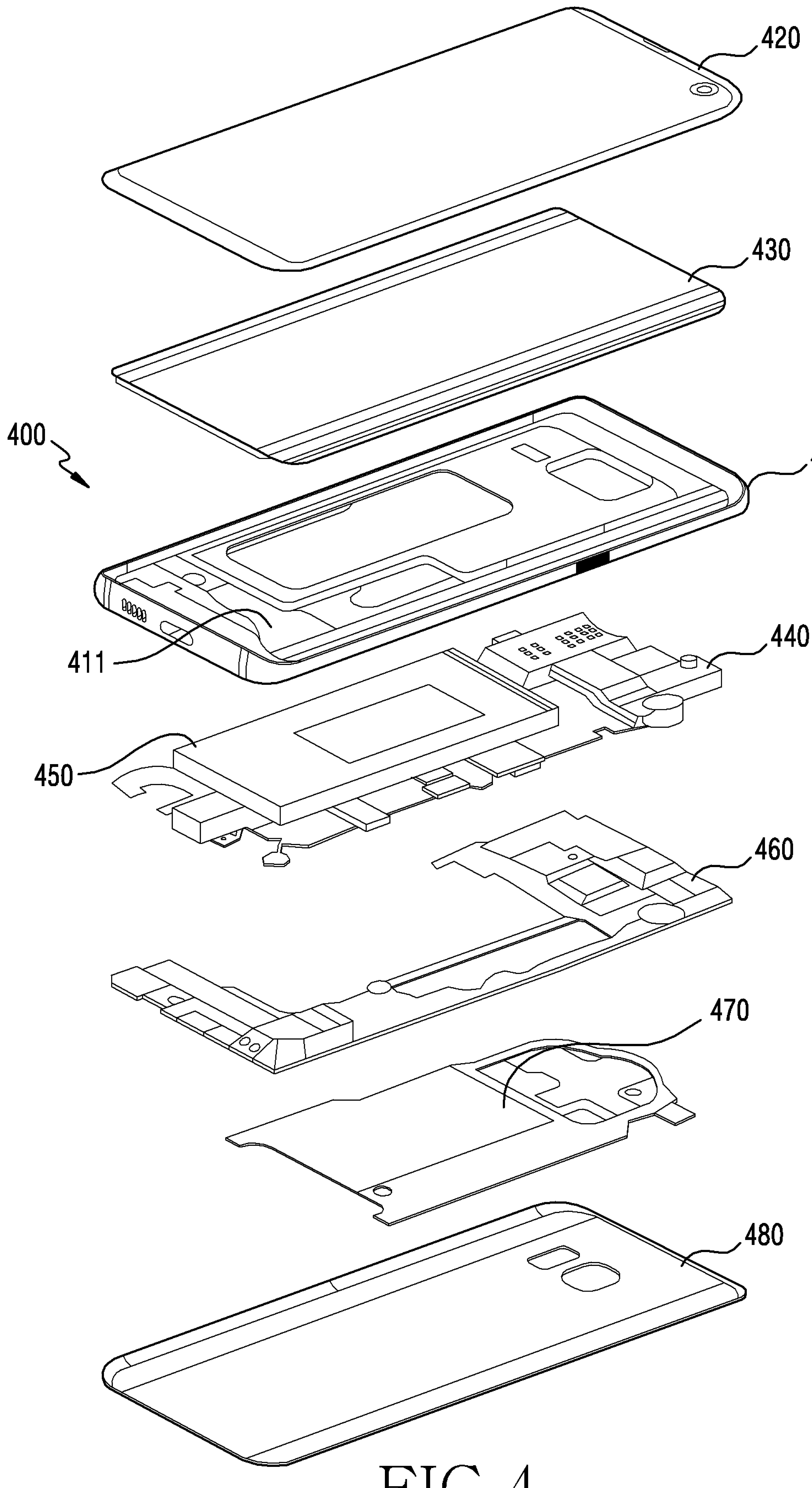


FIG.4

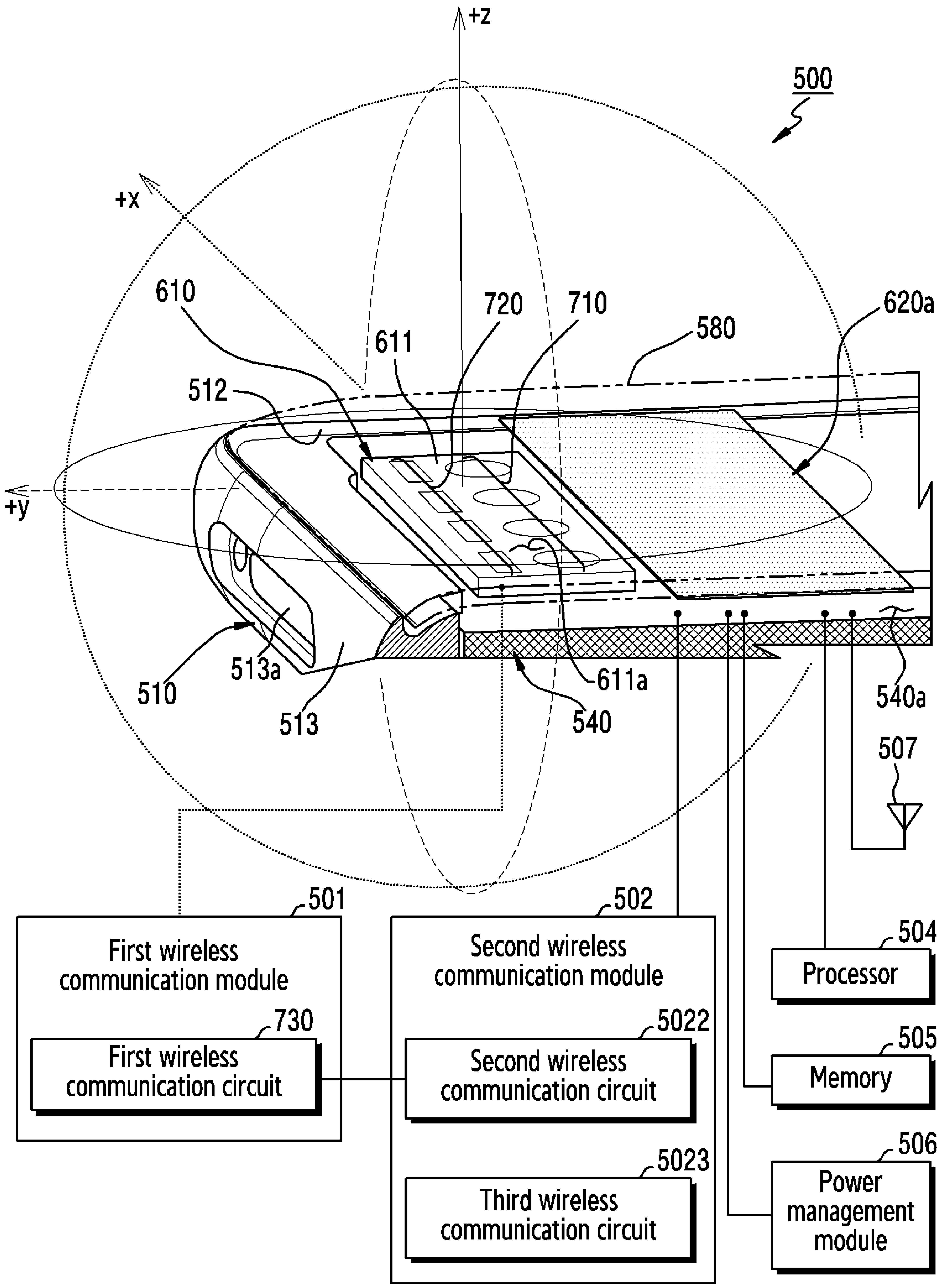

+z
500
+x
610
720
710
611
580
620a
512
+y
510
513a
513
611a
540
540a
507
501
First wireless communication module
730
First wireless communication circuit
502
Second wireless communication module
5022
Second wireless communication circuit
5023
Third wireless communication circuit
504
Processor
505
Memory
506
Power management module

FIG.5A

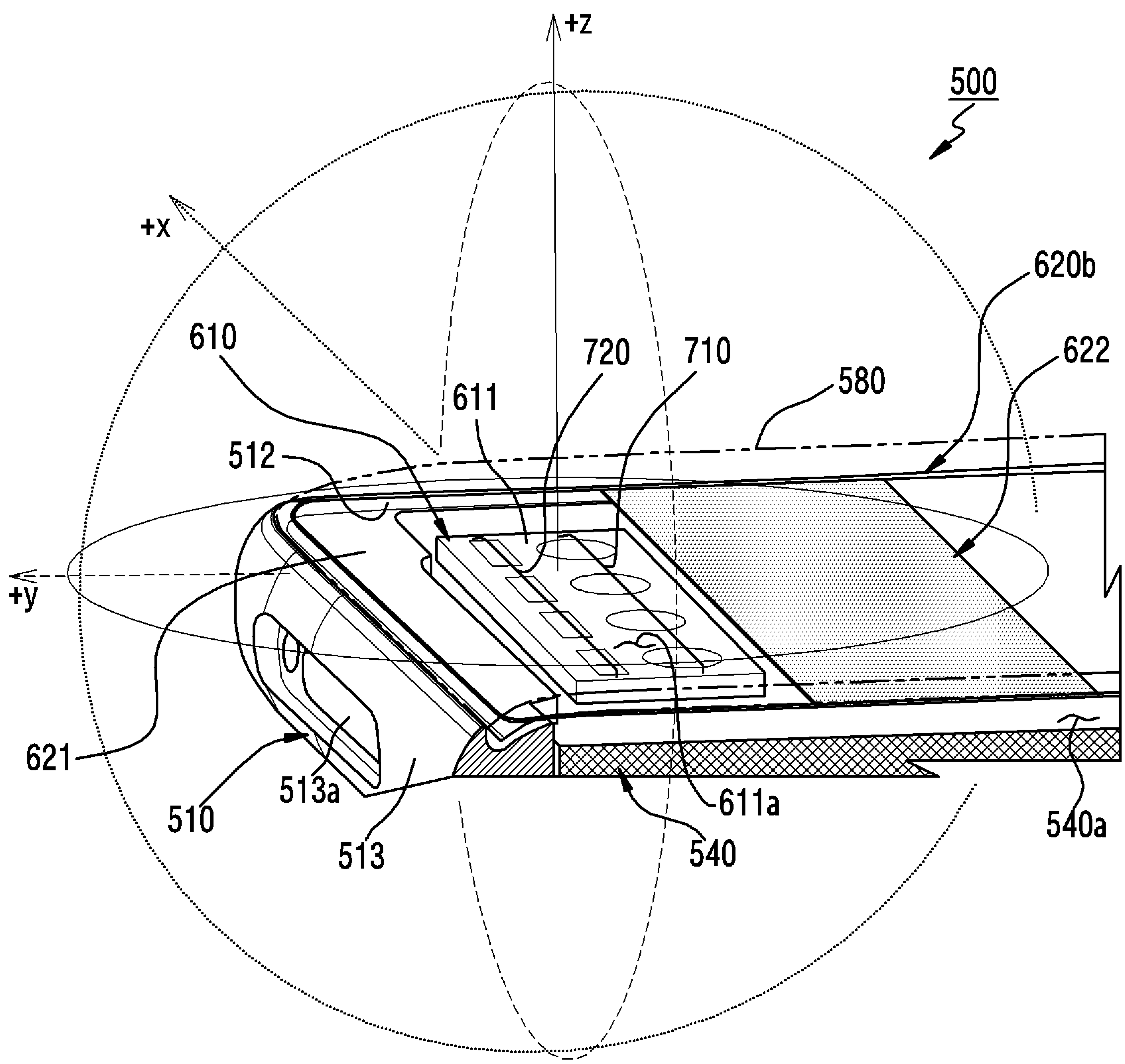

+z
500
+x
620b
622
610
720
710
580
611
512
+y
621
510
513a
513
540
611a
540a

FIG.5B

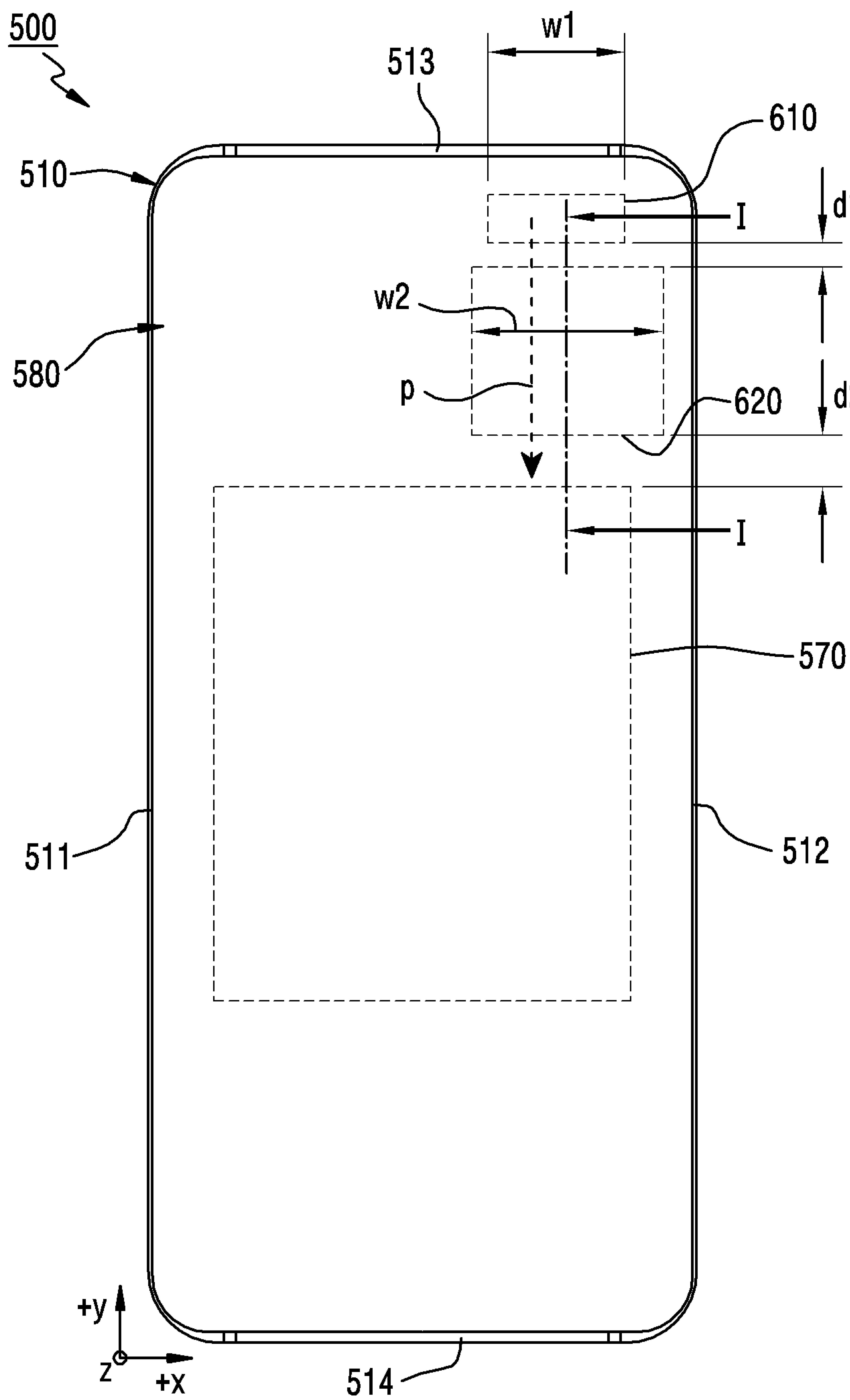


FIG.6

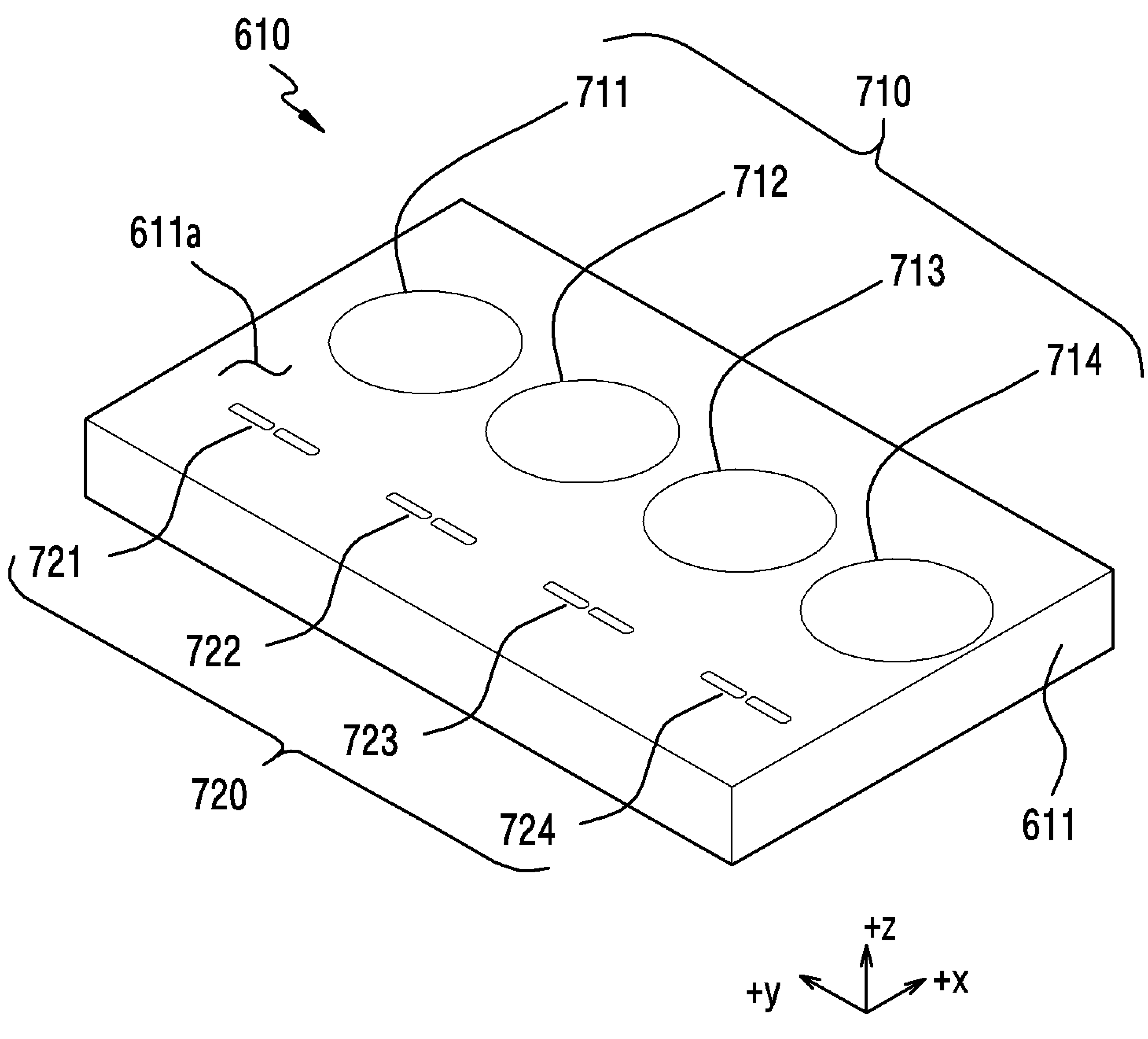


FIG.7A

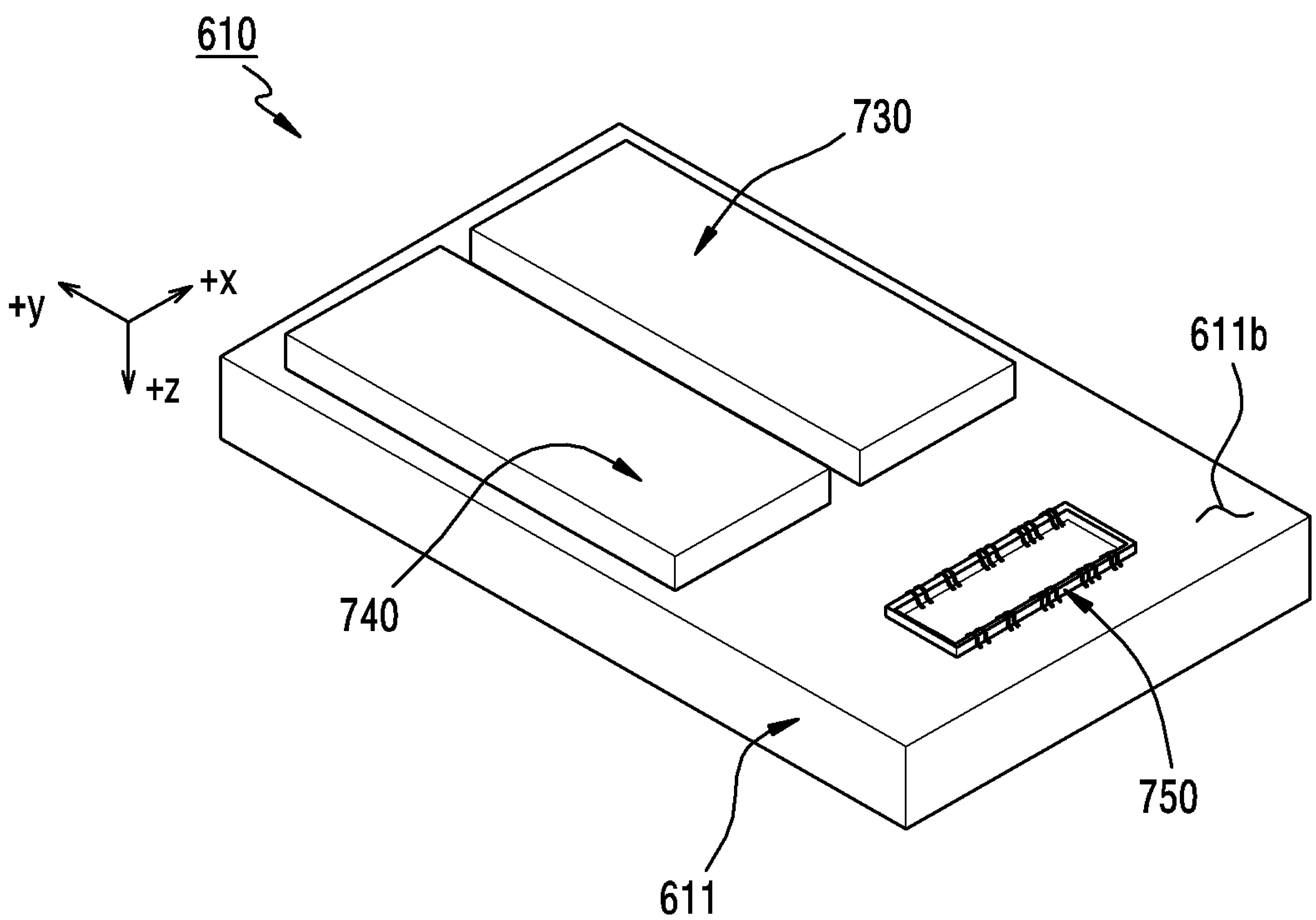


FIG.7B

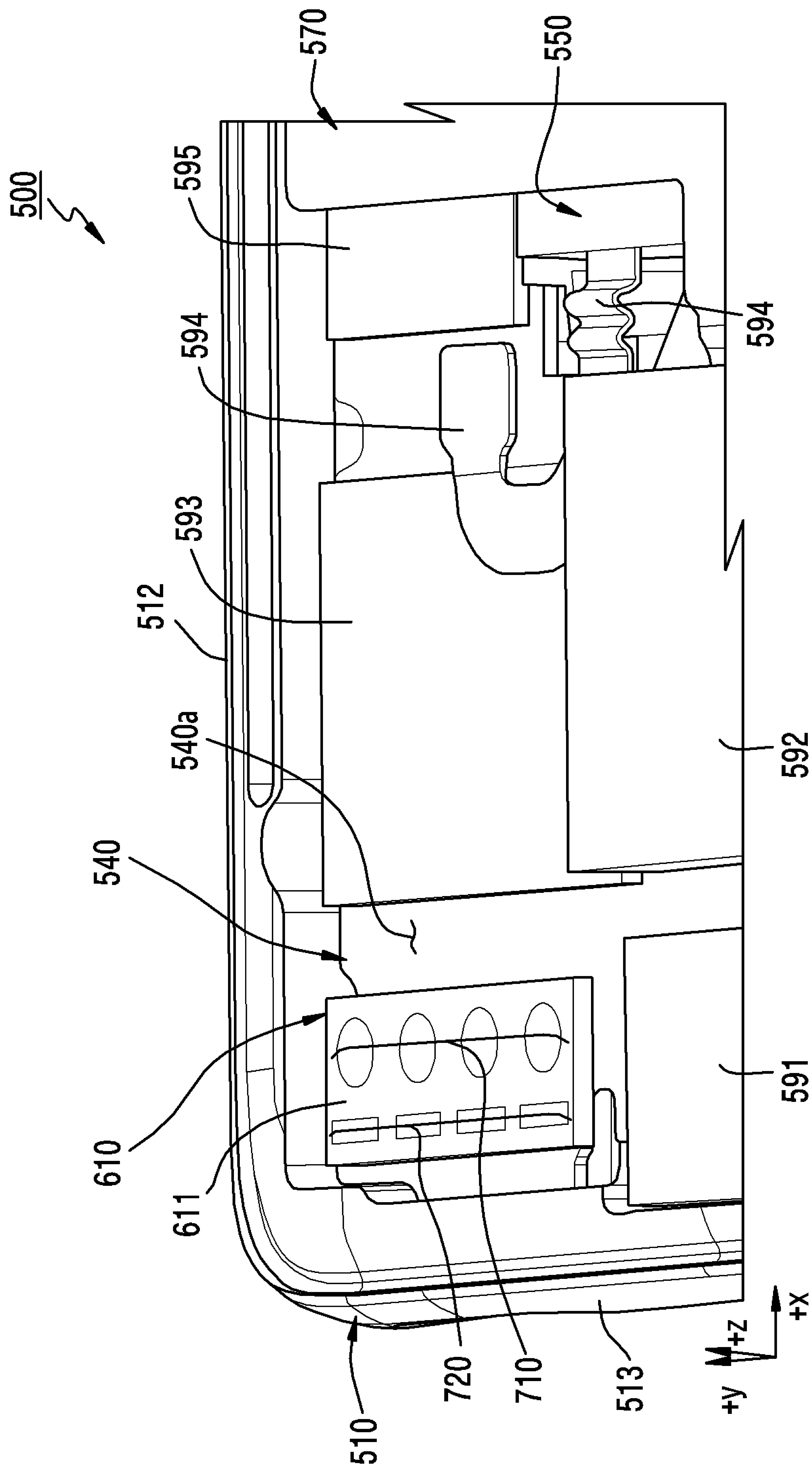

500
570
550
595
594
594
593
512
540a
592
540
610
611
591
510
720
710
513
+y
+z
+x

FIG.8

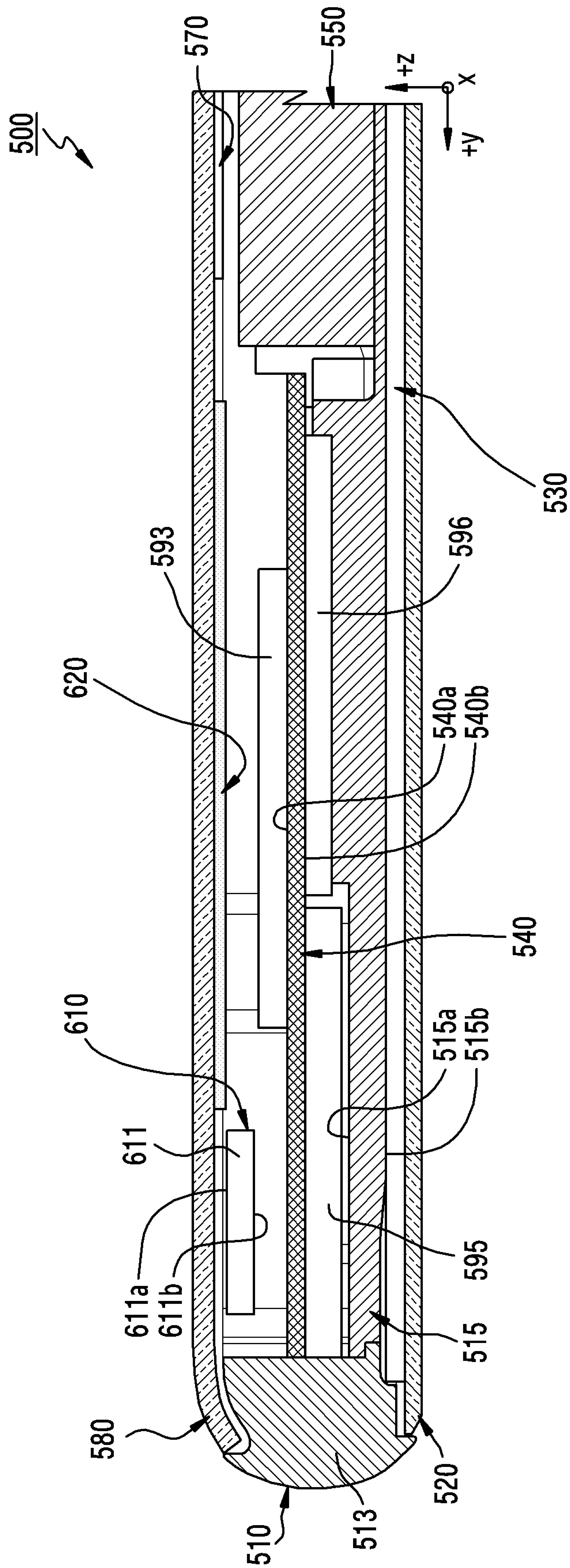

500
570
550
+z
x
+y
530
593
596
620
540a
540b
540
610
515a
515b
611
611a
611b
595
515
580
520
510
513

FIG.9

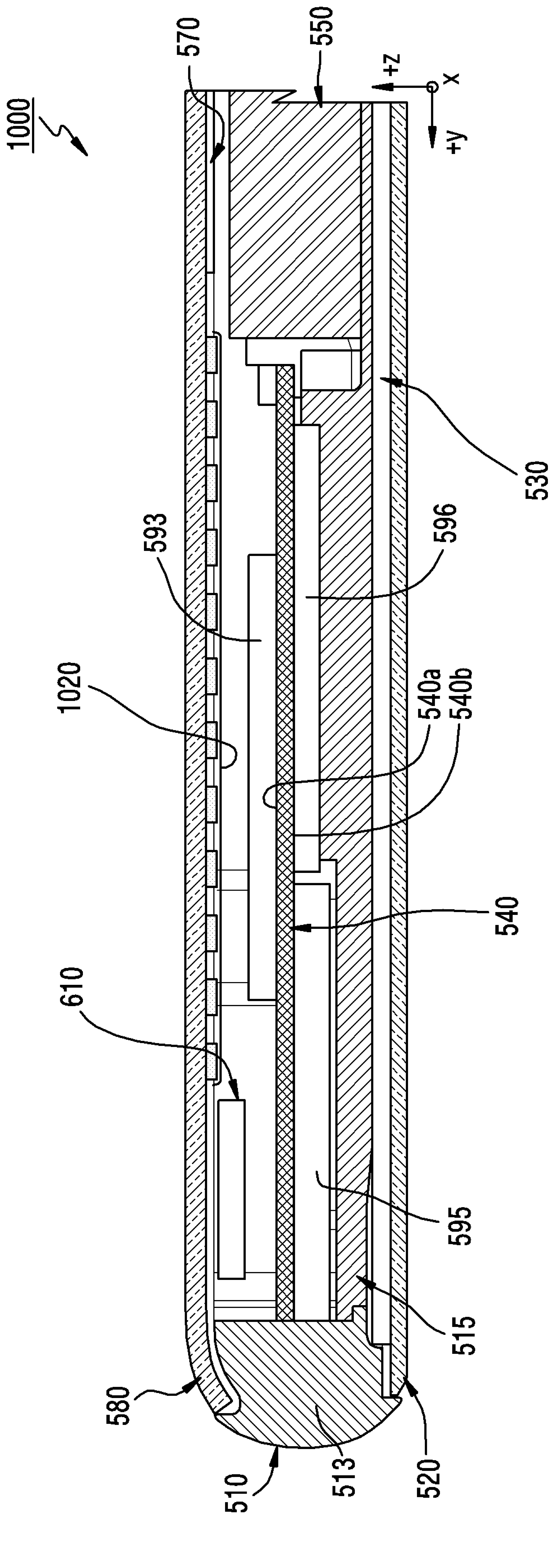

1000
570
550
+z
x
+y
530
596
593
1020
540a
540b
540
610
595
515
580
510
513
520

FIG. 10

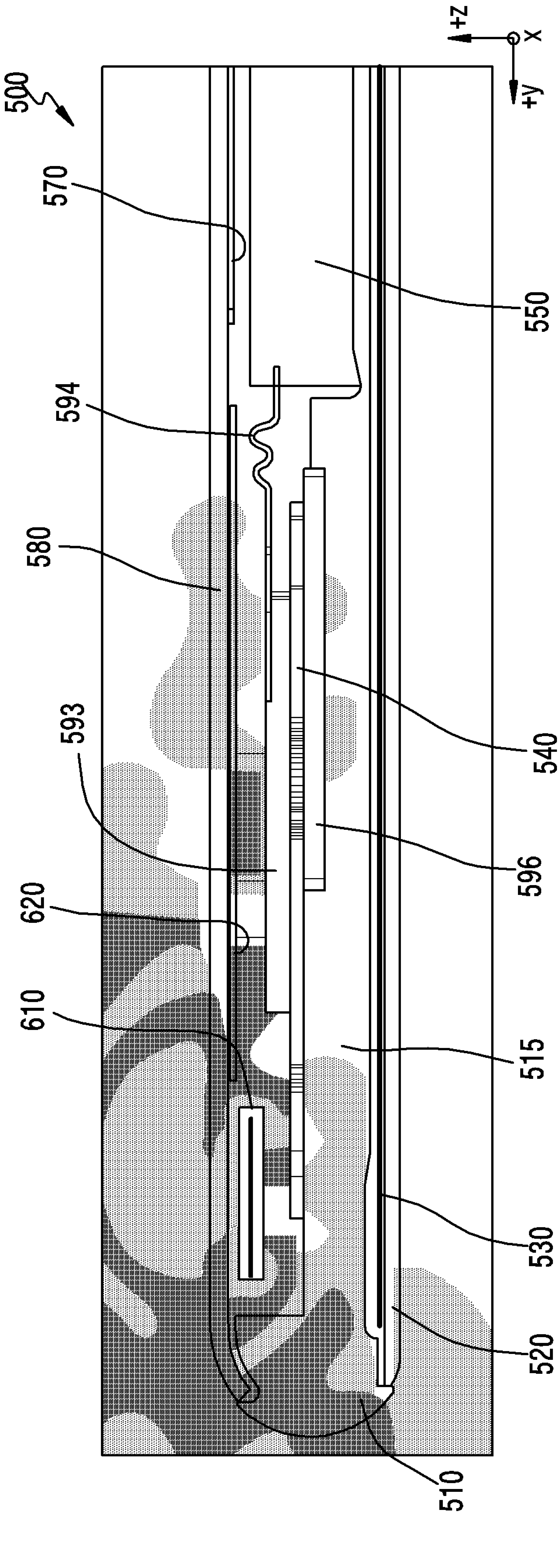


FIG. 11

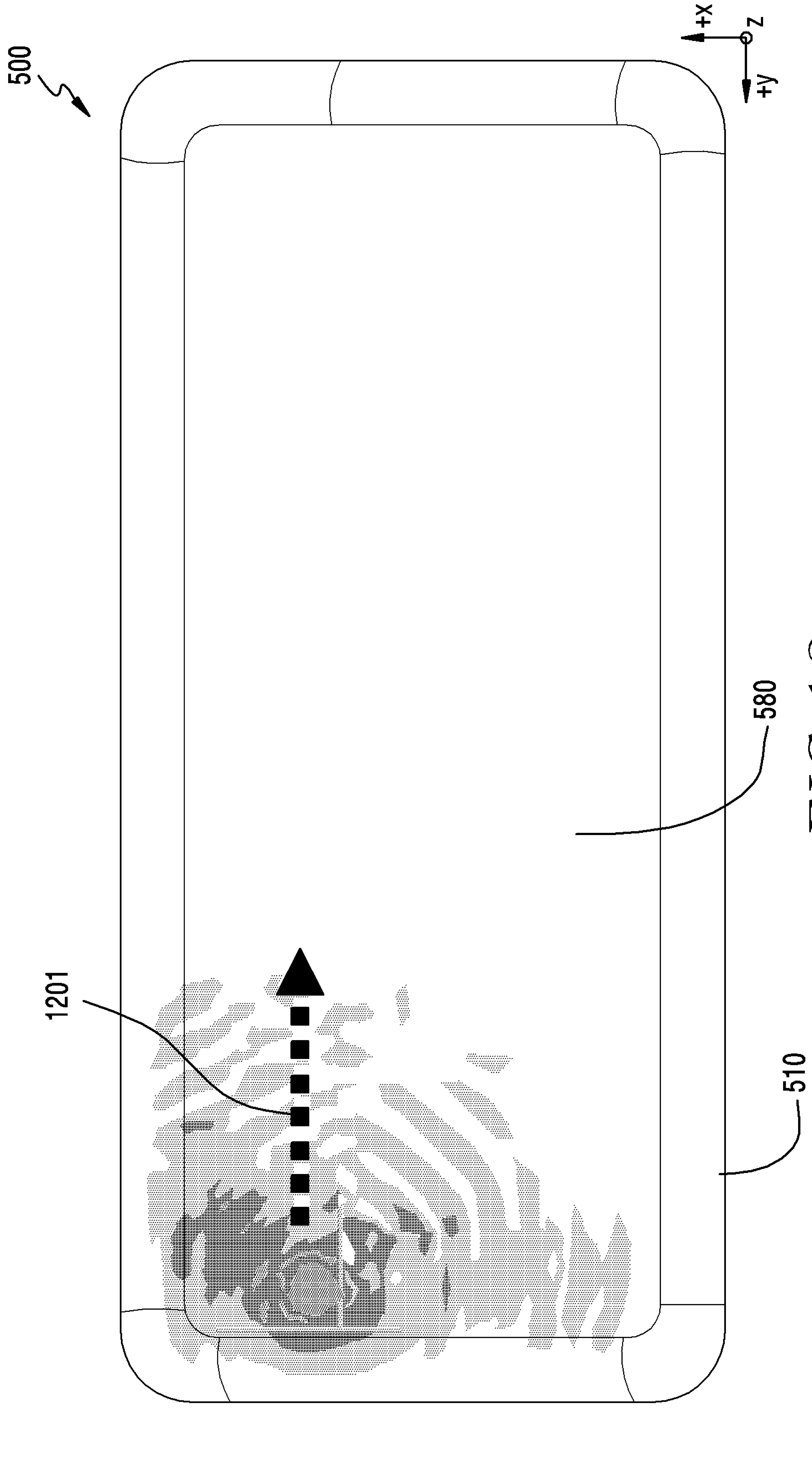


FIG.12

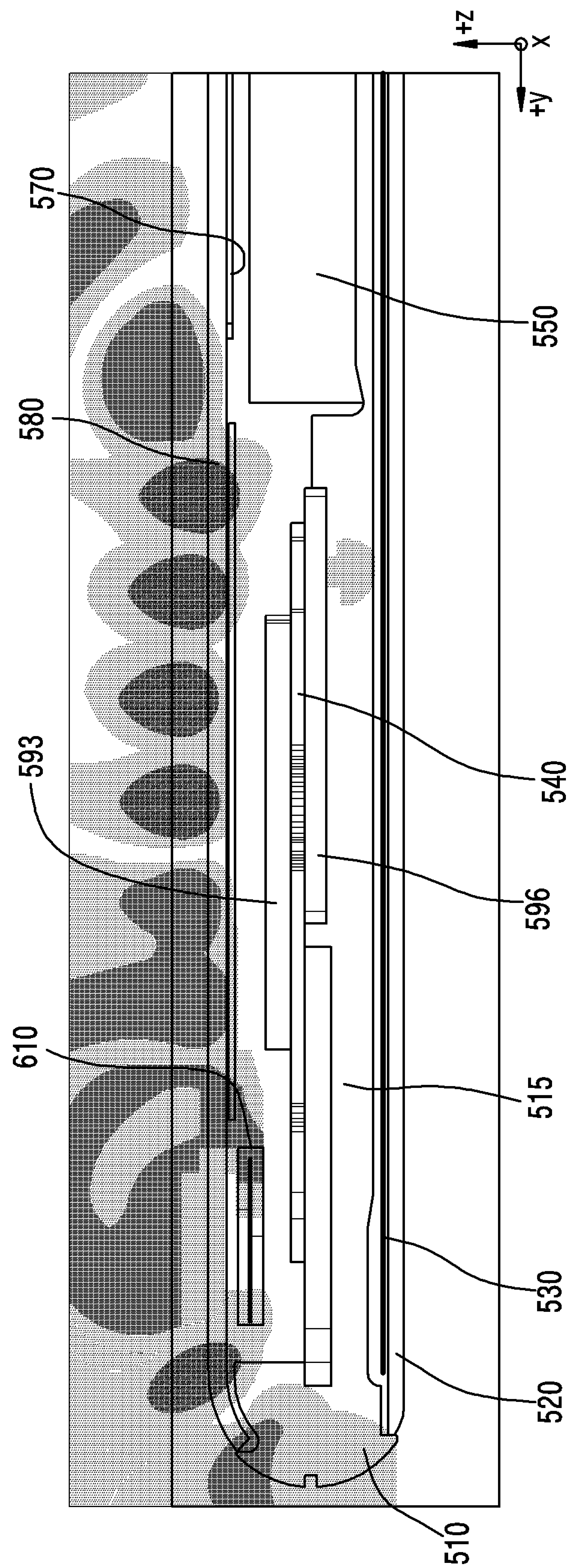


FIG. 13

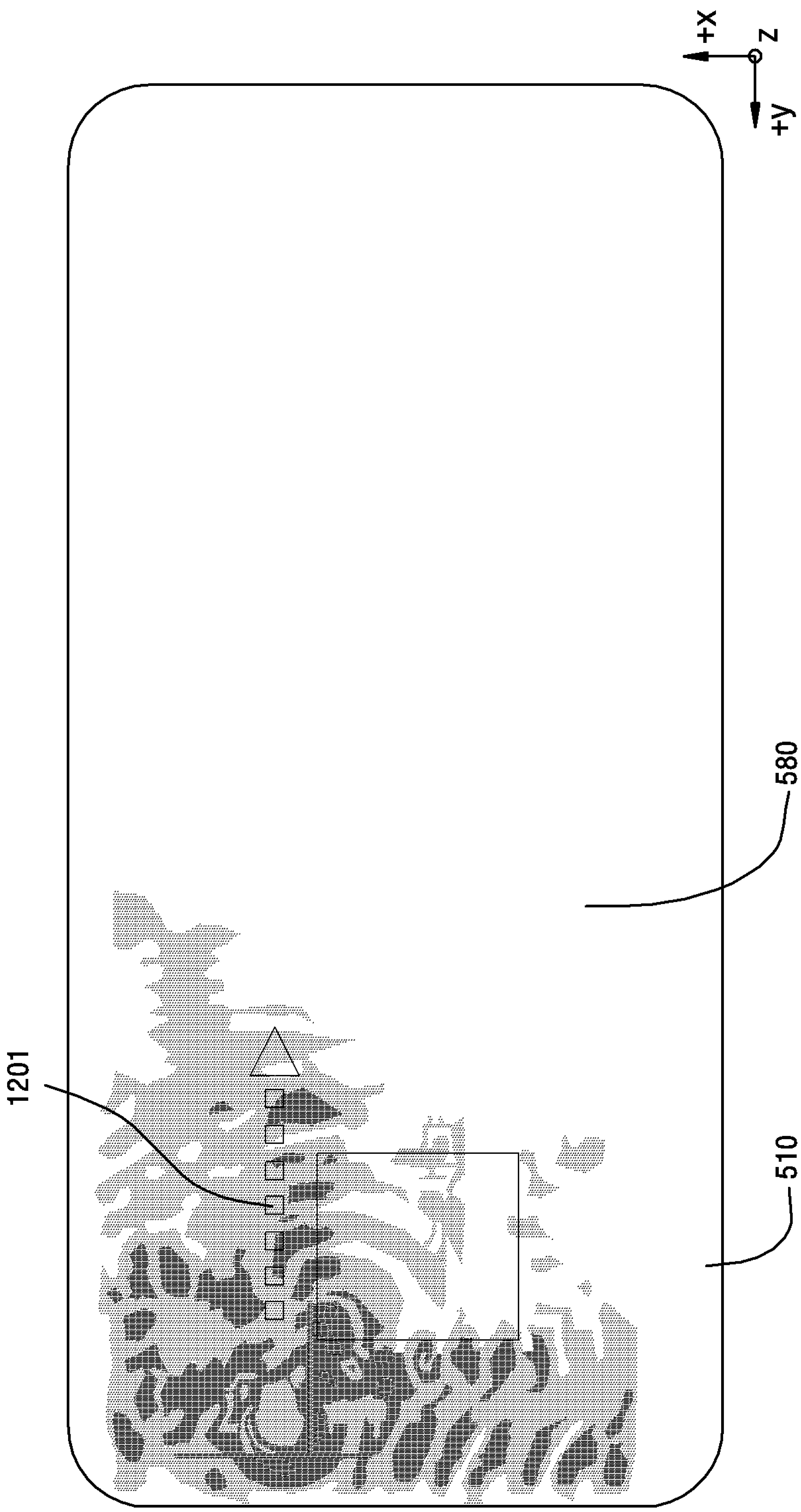


FIG. 14

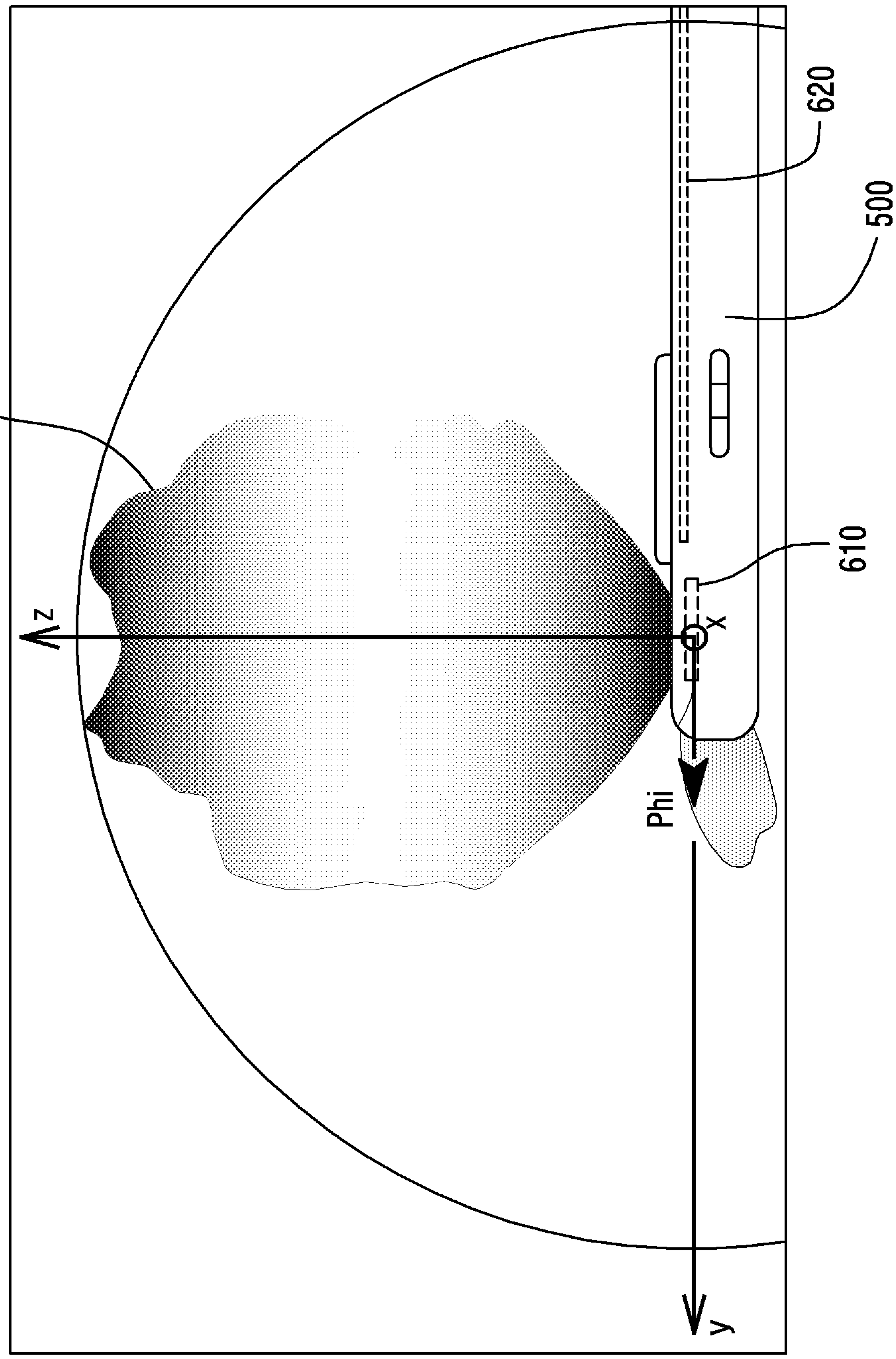


FIG. 15

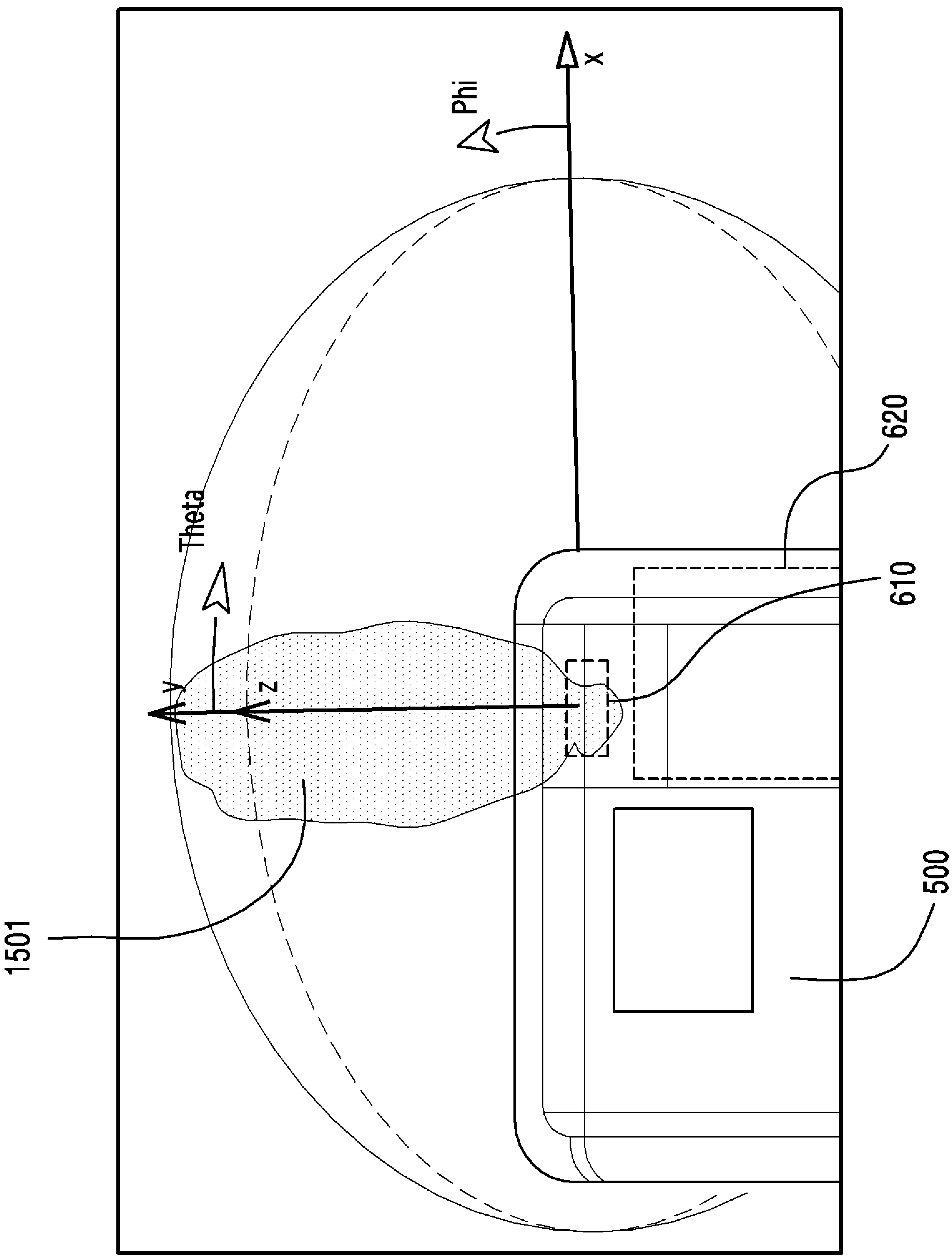


FIG.16

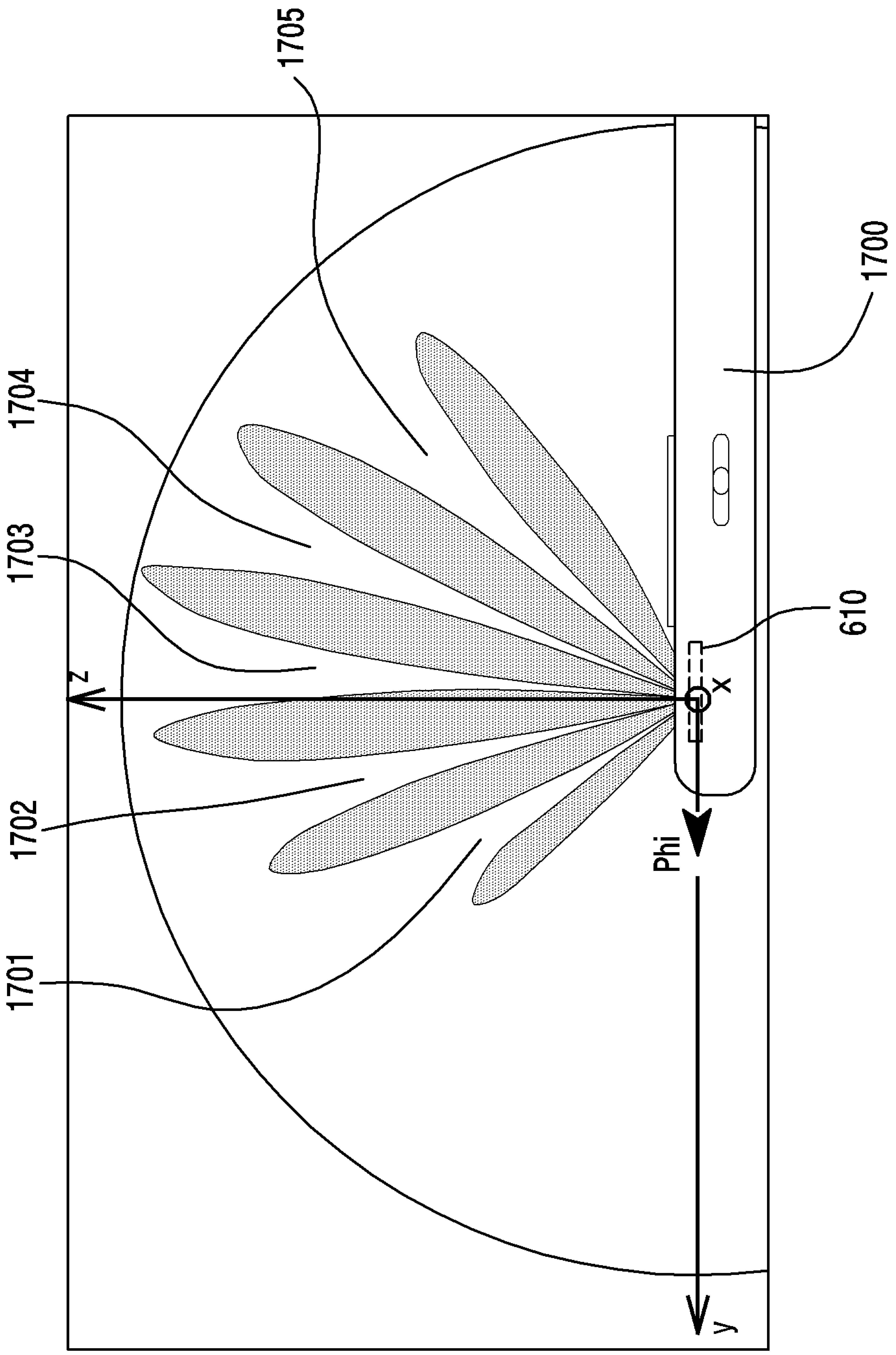


FIG.17

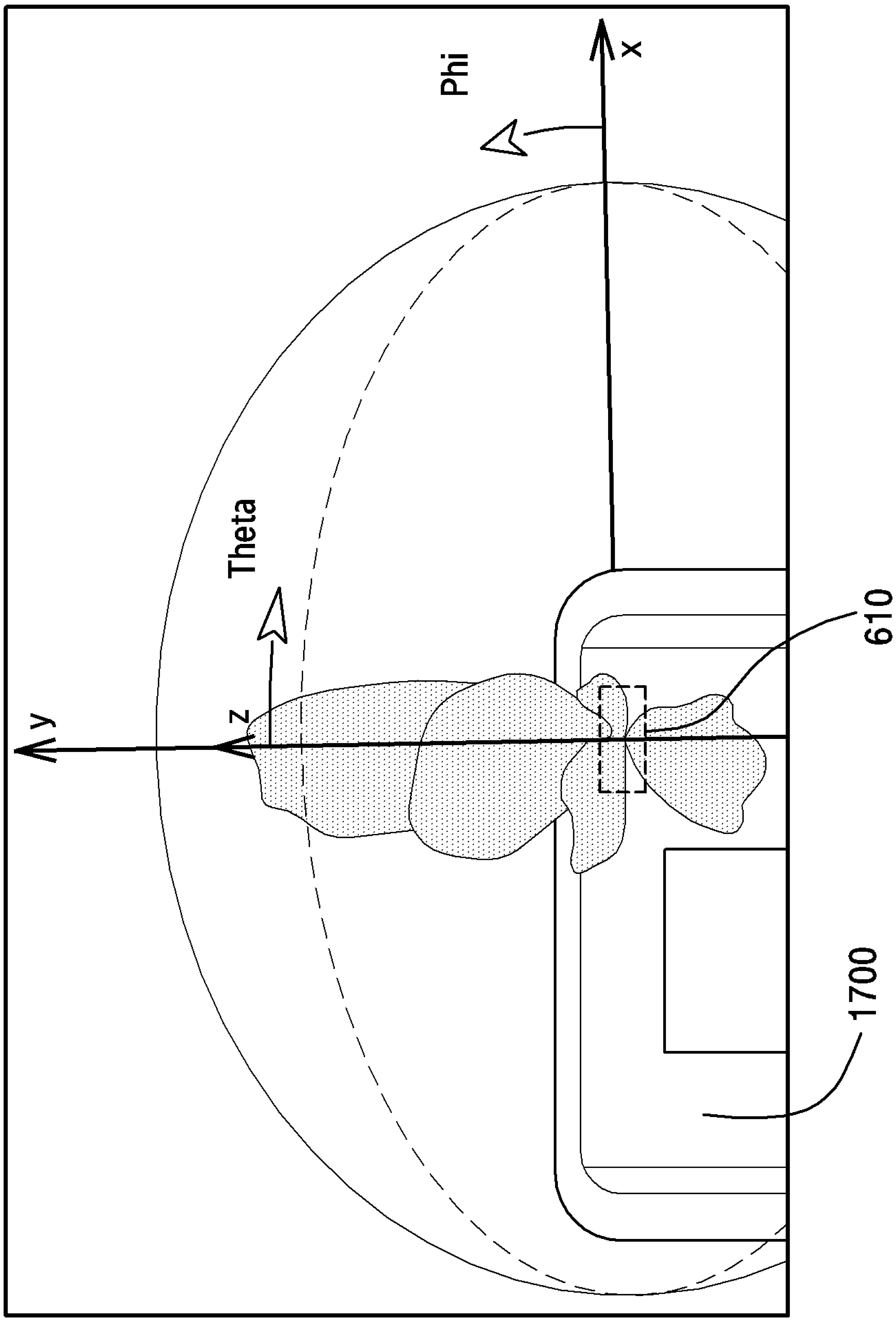


FIG.18

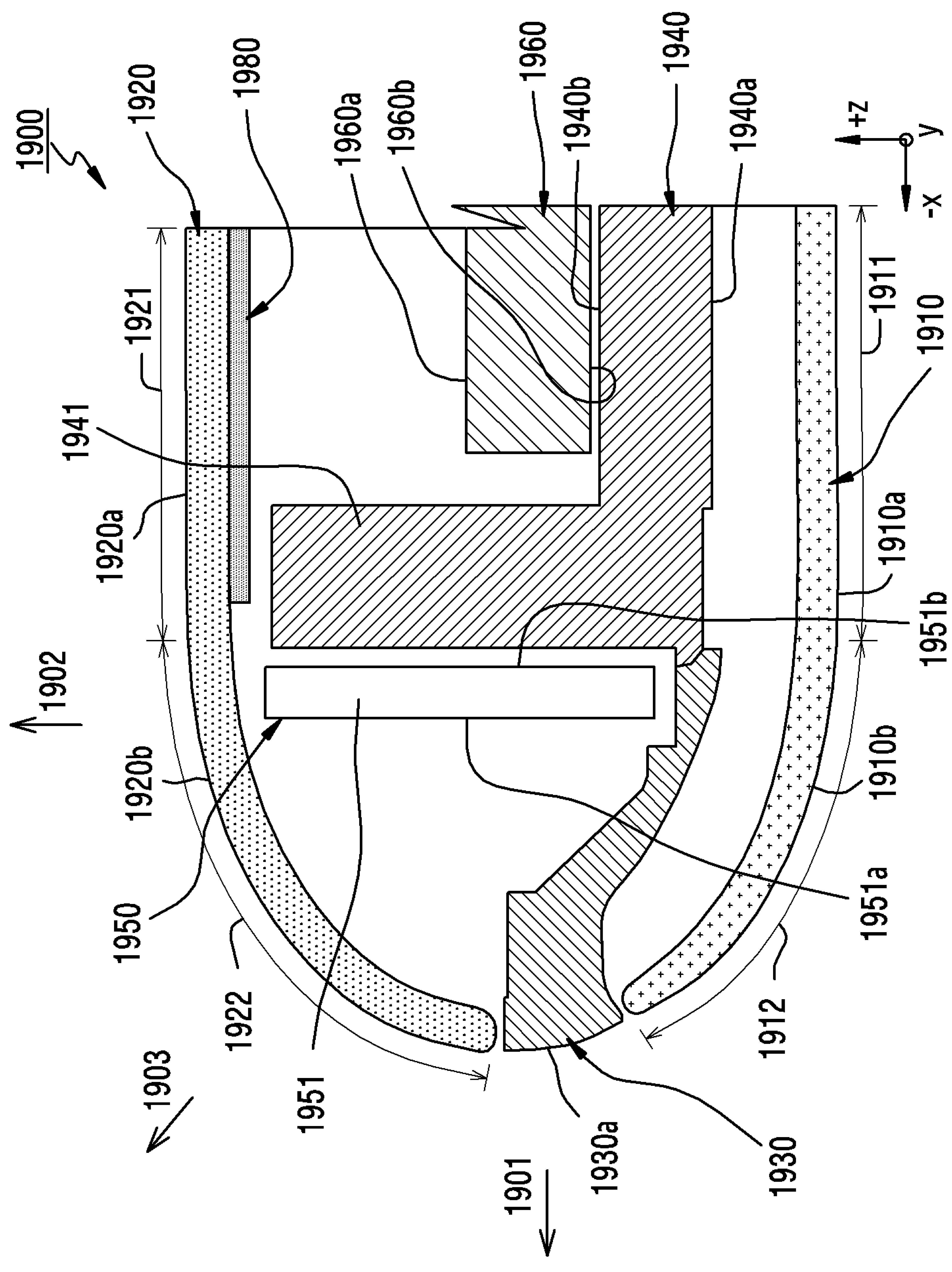
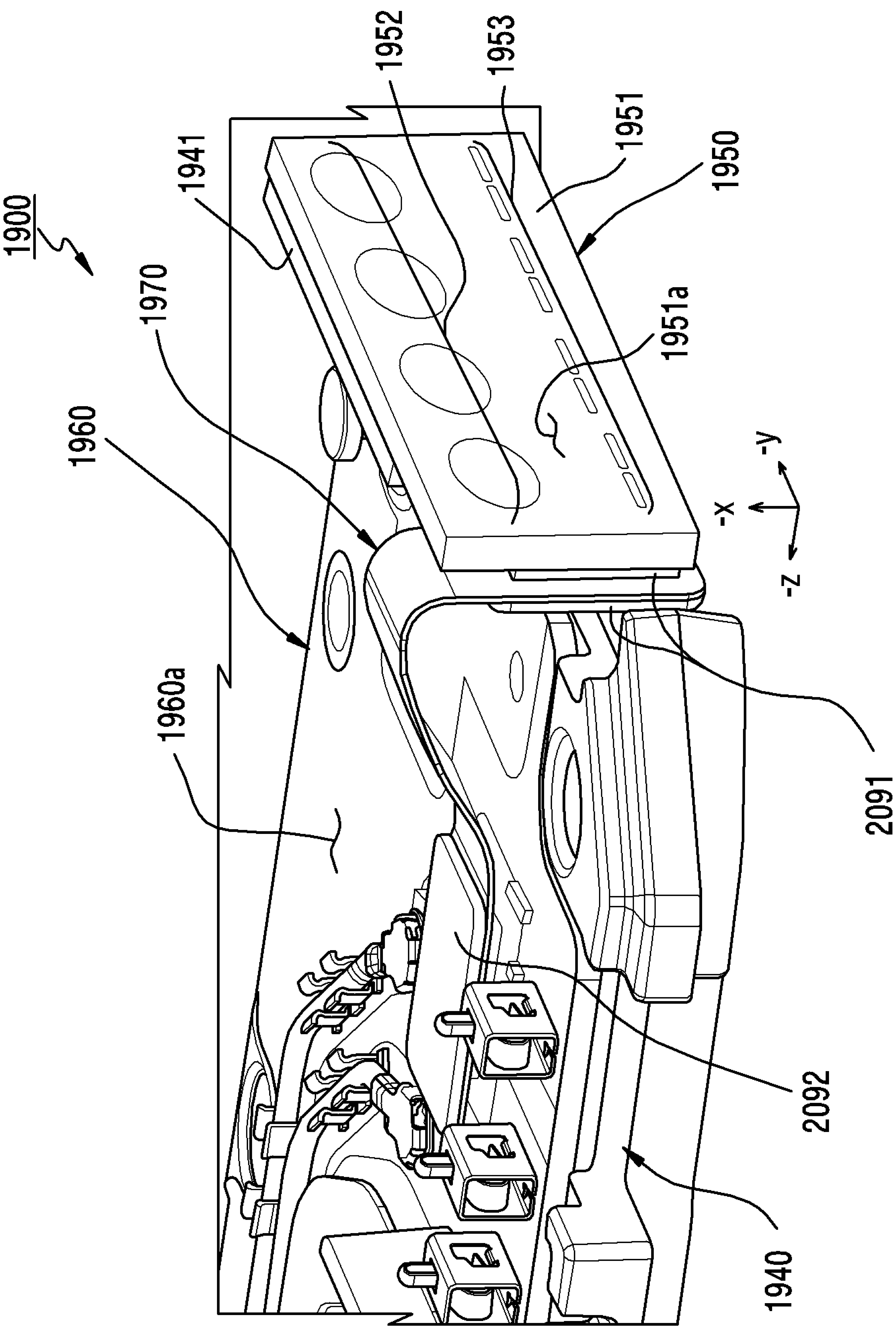

1900
1920
1980
1960a
1960b
1960
1940b
1940
1940a
+z
y
-x
1921
1911
1910
1941
1920a
1910a
1951b
1902
1920b
1910b
1950
1951a
1922
1912
1903
1951
1930a
1930
1901

FIG. 19



1900
1941
1952
1953
1951
1950
1970
1960
1951a
-x
-y
-z
1960a
2091
2092
1940

FIG.20

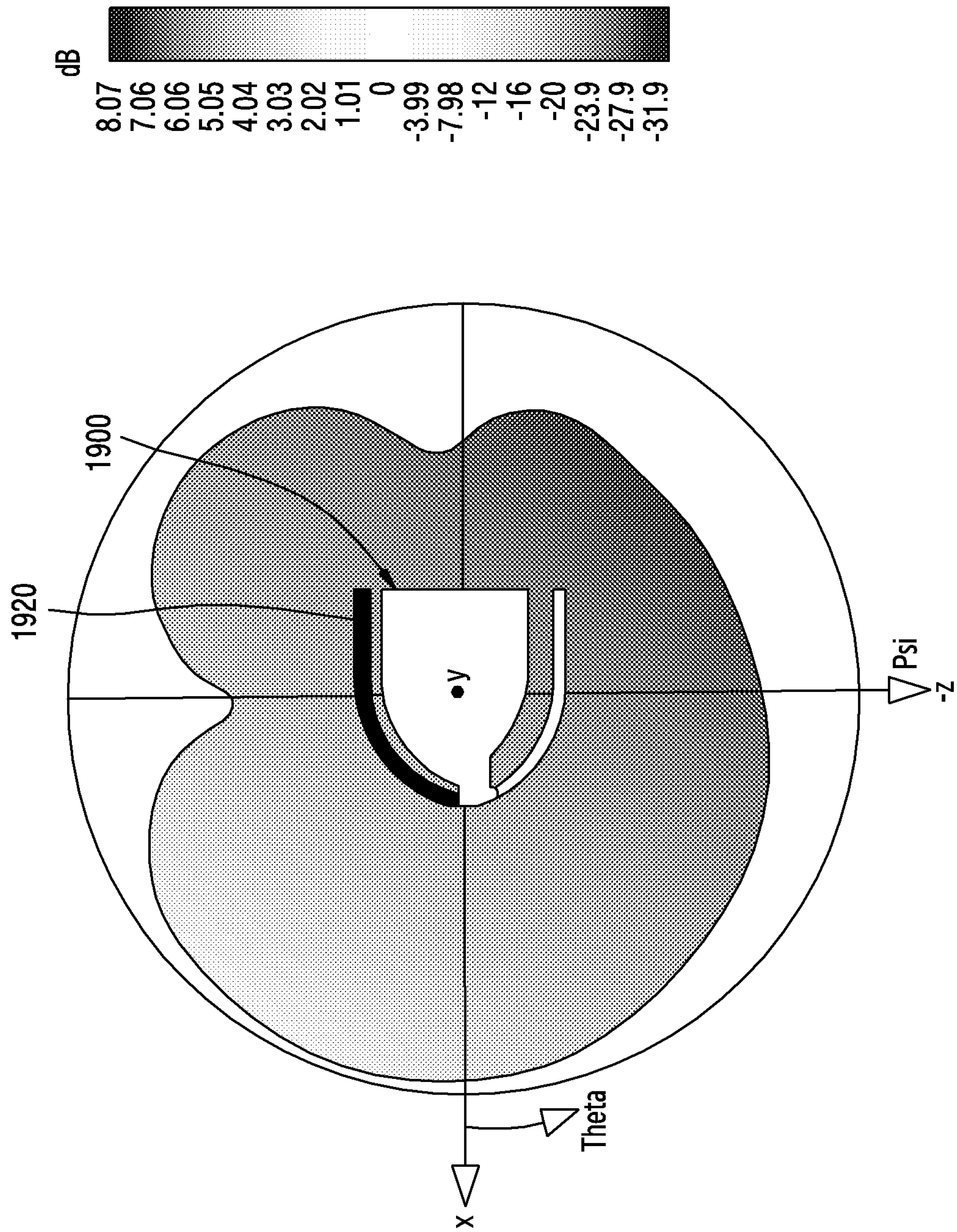

dB
8.07
7.06
6.06
5.05
4.04
3.03
2.02
1.01
0
-3.99
-7.98
-12
-16
-20
-23.9
-27.9
-31.9
1920
1900
y
Psi
-z
Theta
x

FIG.21

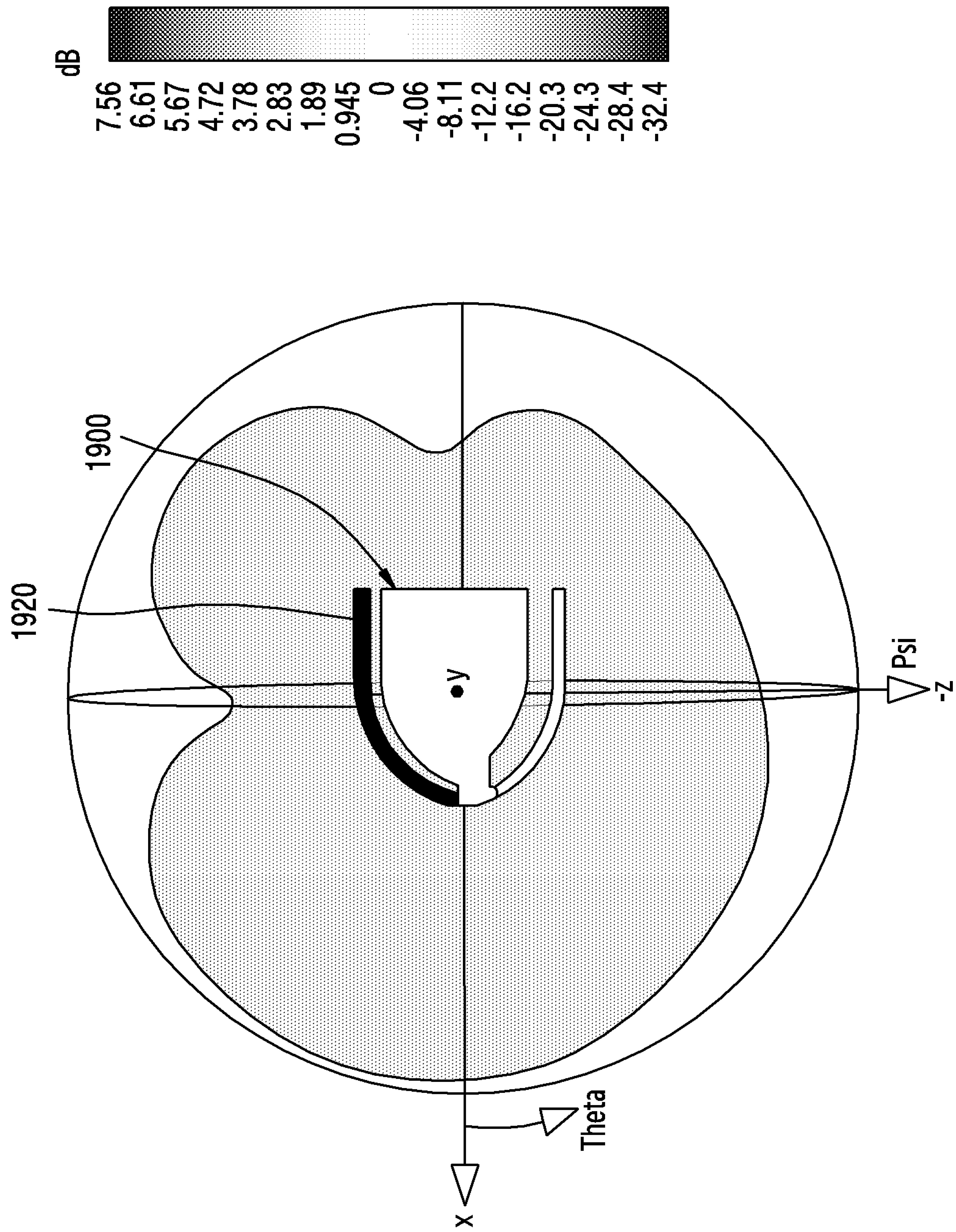

dB
7.56
6.61
5.67
4.72
3.78
2.83
1.89
0.945
0
-4.06
-8.11
-12.2
-16.2
-20.3
-24.3
-28.4
-32.4
1900
1920
y
Psi
-z
x
Theta

FIG.22

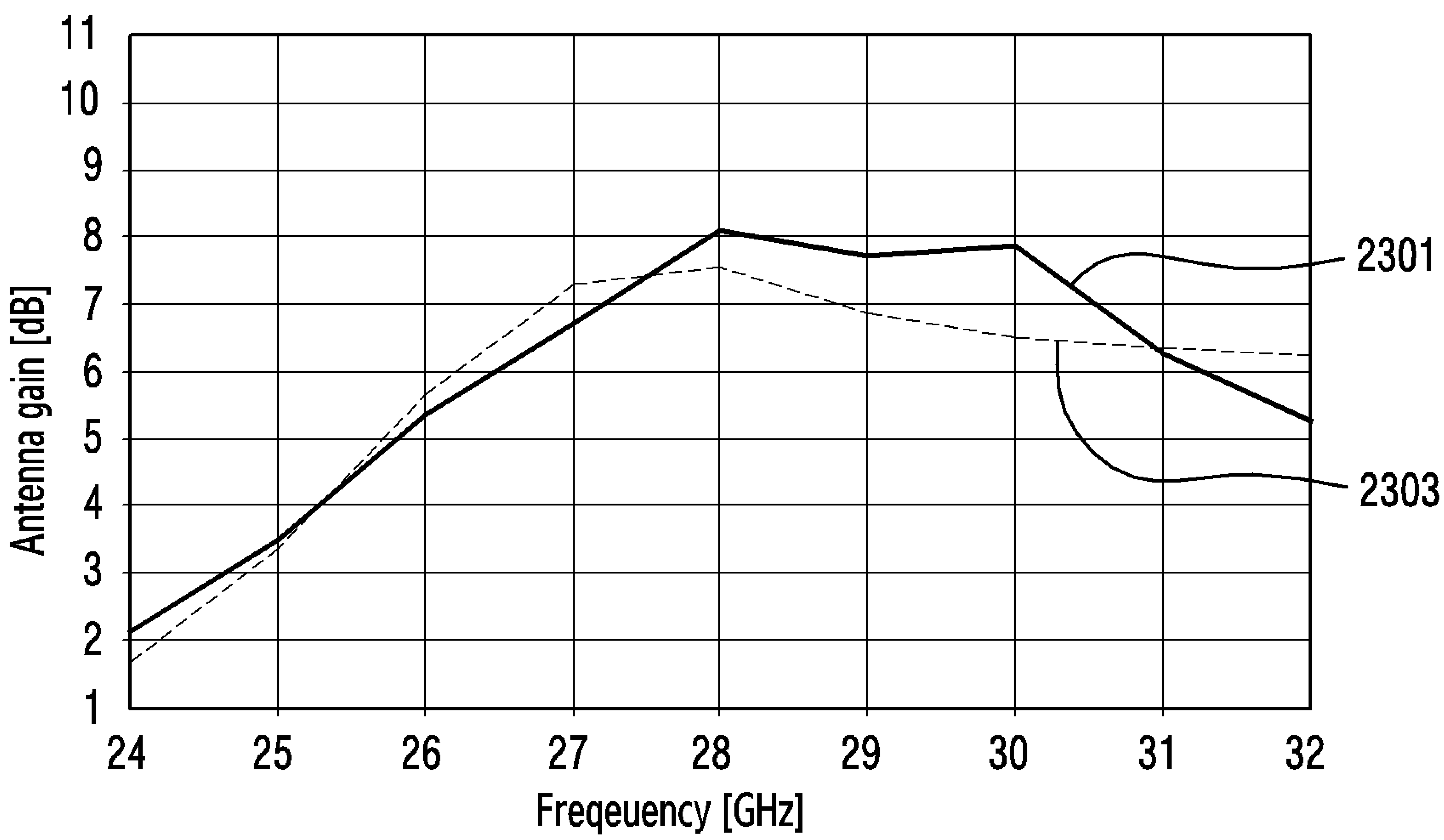

11
10
9
8
7
6
5
4
3
2
1
Antenna gain [dB]
24
25
26
27
28
29
30
31
32
Freqeuency [GHz]
2301
2303

FIG.23

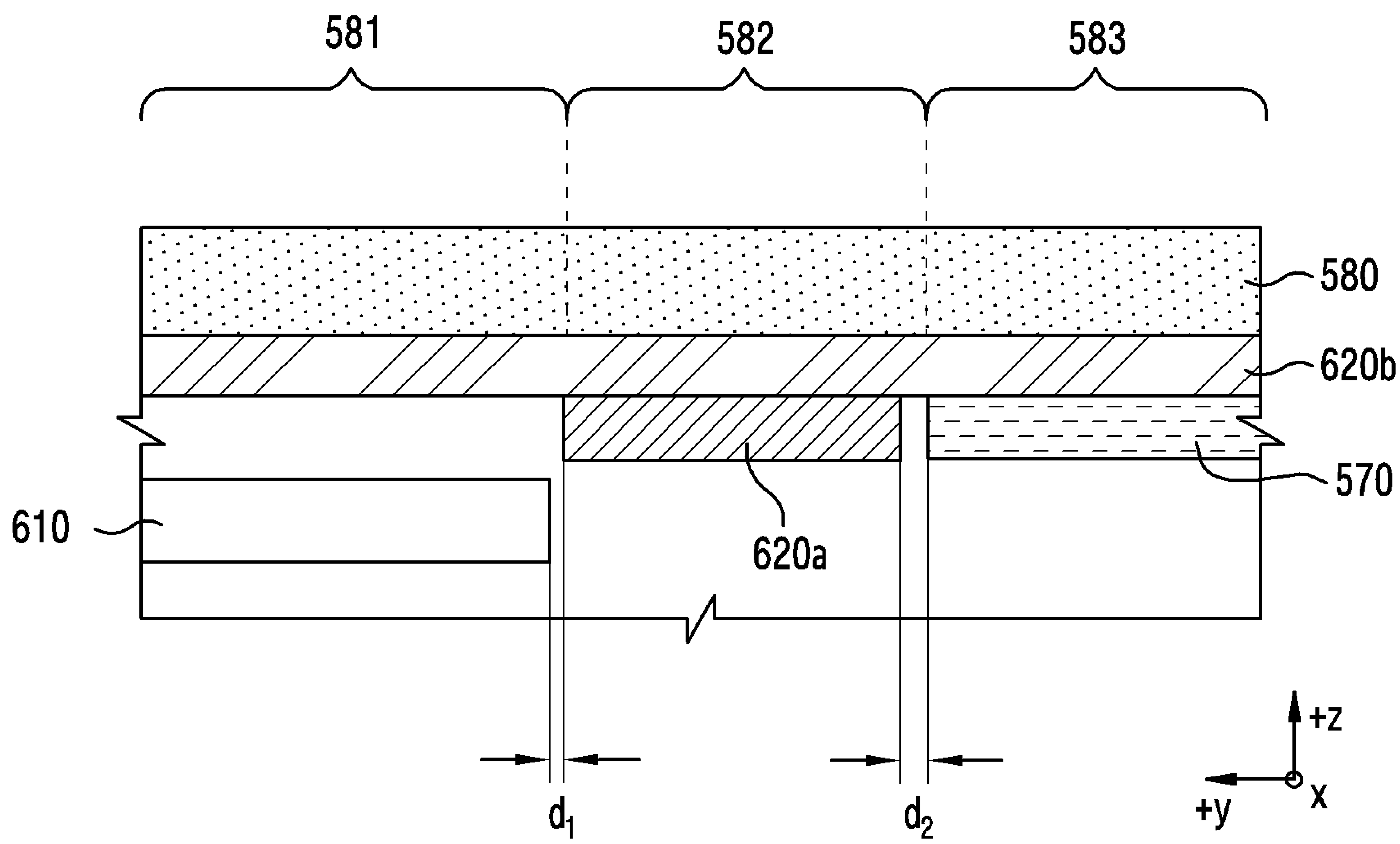


FIG.24

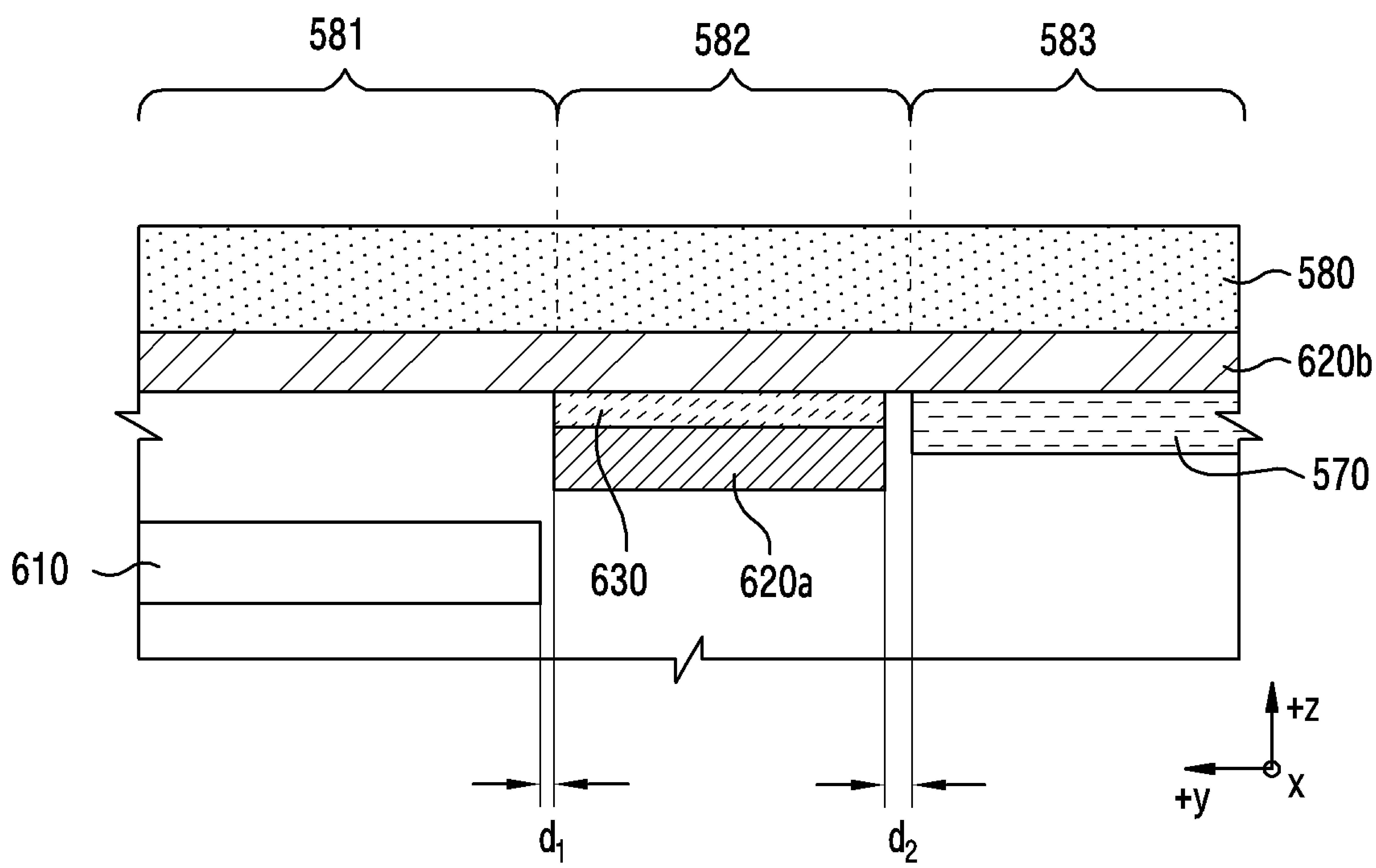


FIG.25

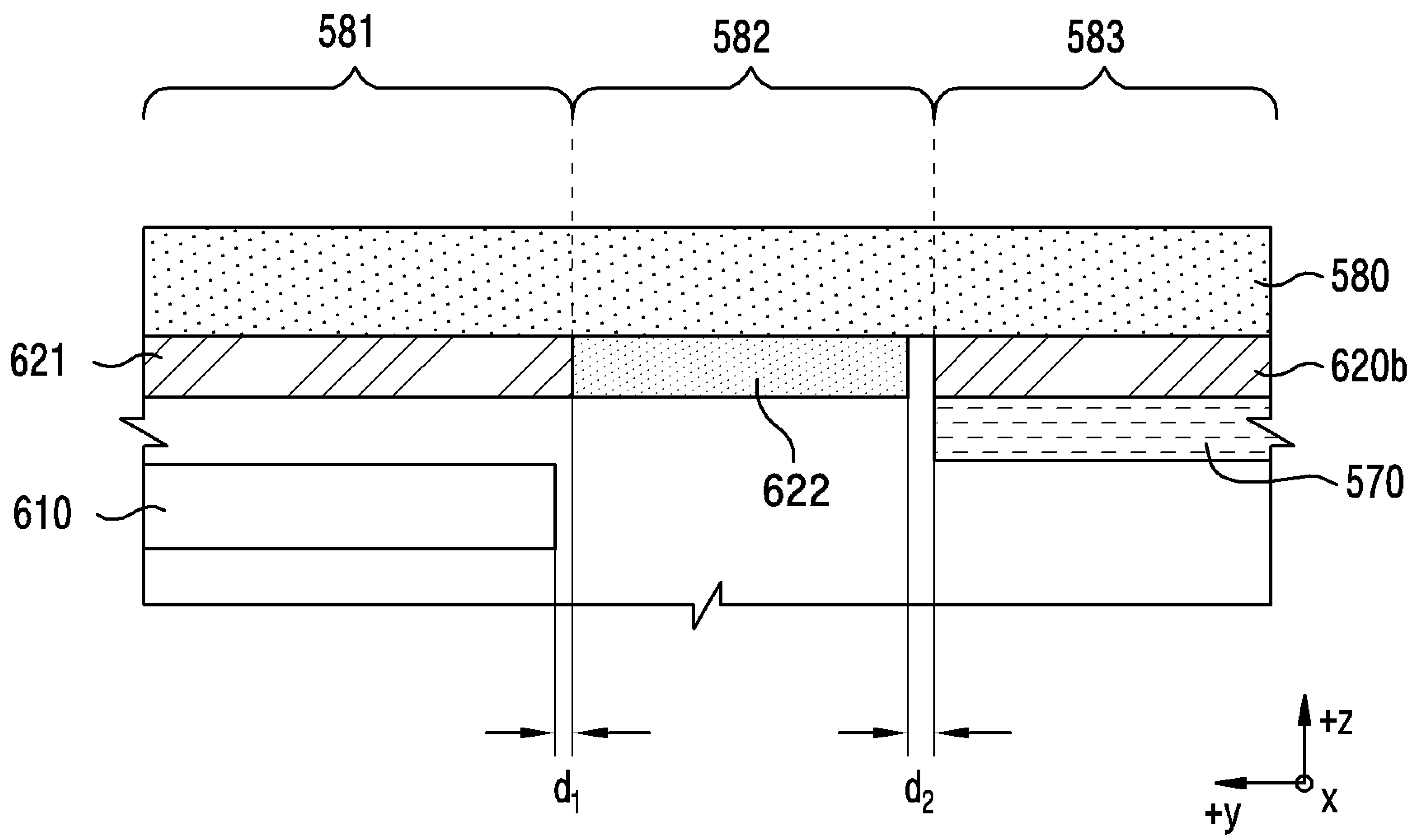


FIG.26

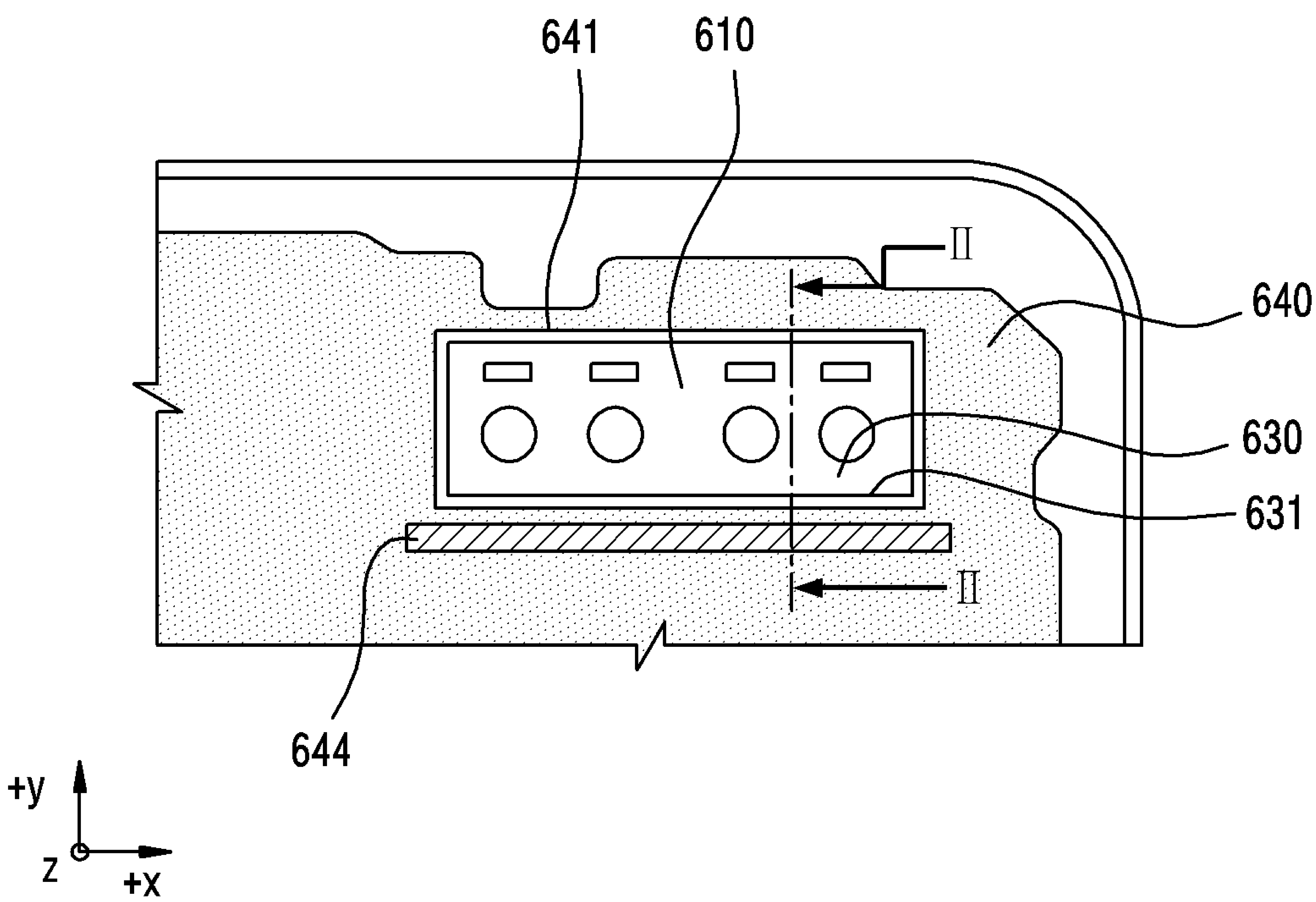


FIG.27

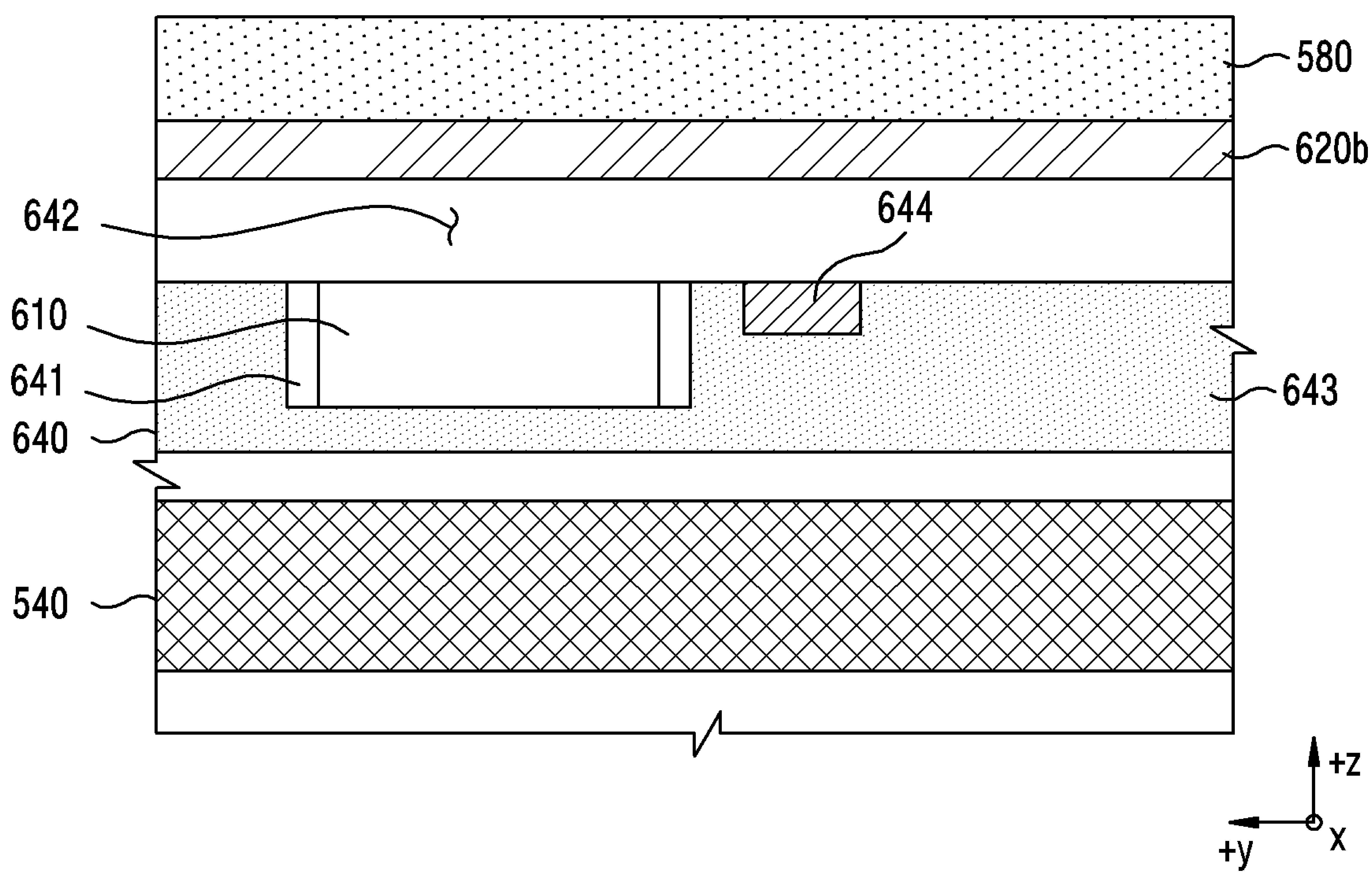


FIG.28

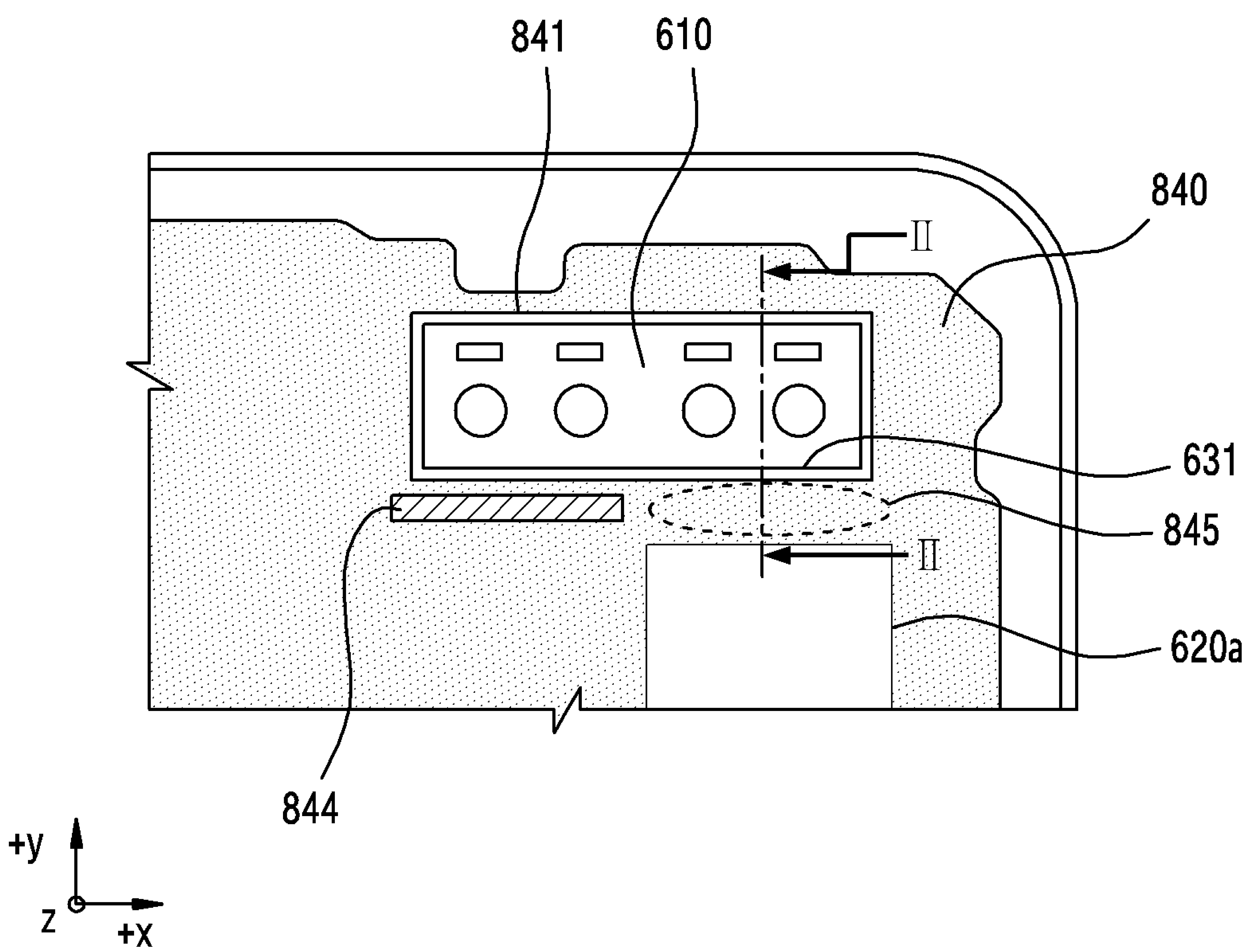


FIG.29

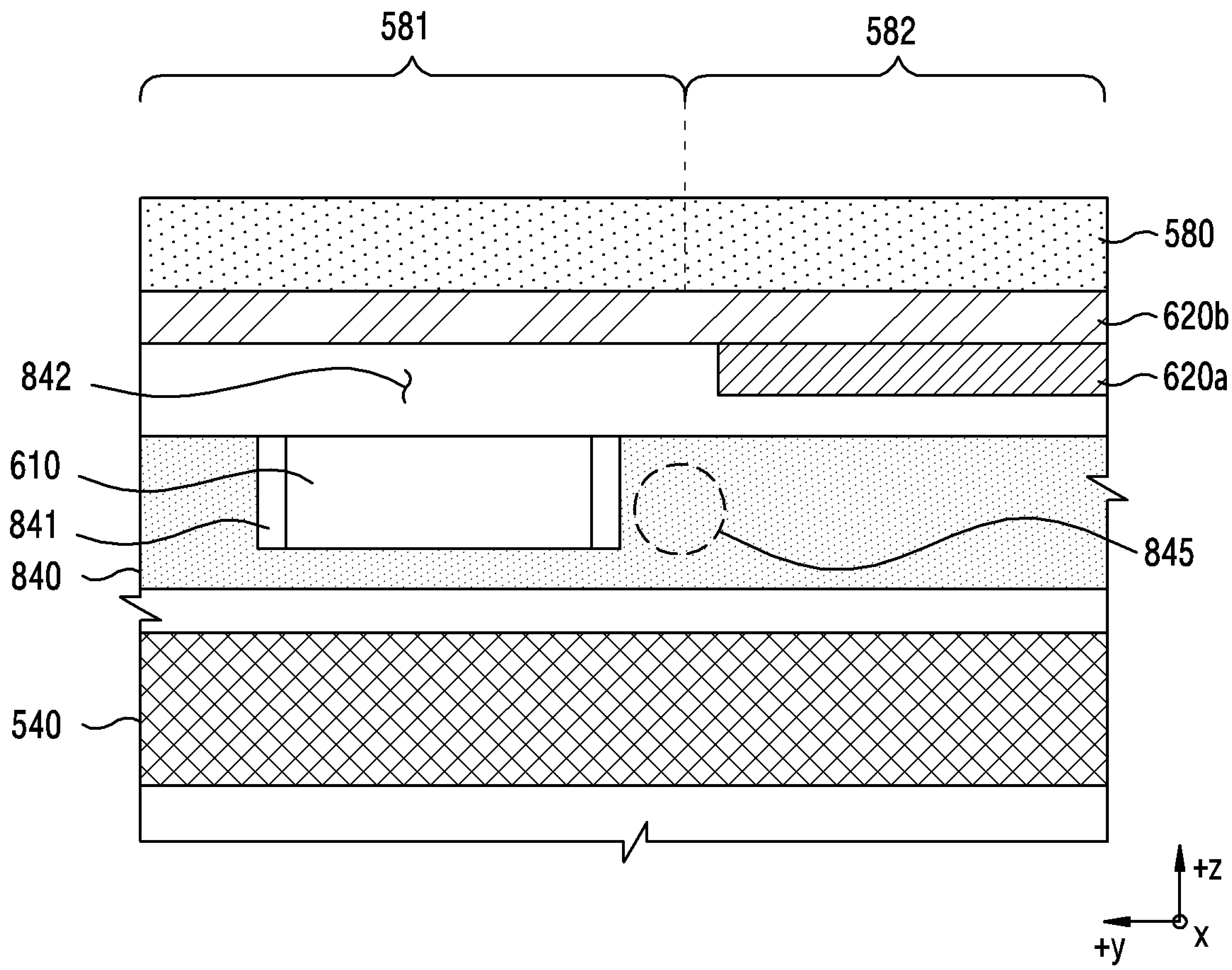


FIG.30

ELECTRONIC DEVICE INCLUDING ANTENNA MODULE

CROSS-REFERENCE TO RELATED APPLICATION(S)

This application is based on and claims priority under 35 U.S.C. § 119(a) of a Korean patent application number 10-2019-0082719, filed on Jul. 9, 2019, in the Korean Intellectual Property Office, and of a Korean patent application number 10-2020-0027269, filed on Mar. 4, 2020, in the Korean Intellectual Property Office, the disclosure of each of which is incorporated by reference herein in its entirety.

BACKGROUND

1. Field

The disclosure relates to an electronic device including an antenna module.

2. Description of Related Art

As digital technologies have developed, electronic devices have been provided in various forms such as smartphones, tablet personal computers (PCs), or personal digital assistants (PDAs). The electronic devices also have been developed to be carried by or mounted on users so as to improve portability and accessibility to the users. As wireless communication technologies have been developed, electronic devices (e.g., communication electronic devices) have been generally used in everyday lives, and accordingly, contents have been increasingly used.

As high-speed wireless communication technologies of high frequency bands have been developed, phased array antennas (e.g., antenna arrays) of high directivity may be used for operations of the electronic devices in mobile environments that correspond to wireless communication systems such as satellite communication, broadcasting, mobile communication, or ground communication. A beam forming system for transmitting or receiving signals may be utilized for the electronic devices such that energy radiated from a phased array antenna is concentrated in a specific direction.

The above information is presented as background information only to assist with an understanding of the disclosure. No determination has been made, and no assertion is made, as to whether any of the above might be applicable as prior art with regard to the disclosure.

SUMMARY

Aspects of the disclosure are to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the disclosure is to provide an electronic device. The electronic device may include a housing that defines an external appearance thereof, and at least a portion of the housing, for example, may be formed of an insulator or a dielectric material such as glass or a polymer. At least a portion of the housing is a waveguide, through which electromagnetic waves formed in a phased array antenna flow, and for example, may be operated as a path for a medium, by which the electromagnetic waves flow by using a total reflection property. The antenna radiation characteristics, for example, may include an antenna radiation pattern or a beam pattern that is a directional function that represents a relative distribution of electric power radiated from an antenna element, and a polarization state (or an antenna polarization) of electromagnetic waves radiated from the antenna element. When the at least a portion of the housing is operated as a waveguide, the antenna radiation characteristics for the phased array antenna become different (e.g., distorted) from the antenna radiation characteristics corresponding to a selected or specified frequency, which may deteriorate the performance of the antenna. When the electromagnetic waves formed in the phased array antenna flow through the at least a portion of the housing, another electrical element (e.g., at least one antenna provided separately from the phased array antenna) may be electrically influenced so that the performance thereof deteriorates.

Aspects of the disclosure, are to address at least the above-mentioned problems and/or disadvantages and to provide at least the advantages described below. Accordingly, an aspect of the disclosure is to provide an electronic device is provided. The electronic device may include an antenna module, for reducing an electrical influence, by a structure such as a housing, on the antenna radiation characteristics (e.g., a polarization state of a beam pattern or electromagnetic waves) of a phased array antenna and an electrical influence, by the electromagnetic waves of the phased array antenna, on another electrical element through the structure.

Additional aspects will be set forth in part in the description which follows and, in part, will be apparent from the description, or may be learned by practice of the presented embodiments.

In accordance with an aspect of the disclosure, a portable communication device is provided. The portable communication device includes a display defining a front surface of the portable communication device, a plate defining a rear surface of the portable communication device and including a nonconductive material, wherein the plate is configured to have a first surface facing an outside of the portable communication device and a second surface facing an inside of the portable communication device, a first antenna module attached to a first area of the second surface or disposed adjacent to the first area, a second antenna module attached to a second area of the second surface or disposed adjacent to the second area, and a conductive member disposed in or attached to a third area between the first area and the second area, wherein the conductive member at least partially interrupts some electric waves, among electric waves radiated from the first antenna module, that travel towards the second antenna module through the plate.

In accordance with another aspect of the disclosure, a portable communication device is provided. The portable communication device includes a display defining a front surface of the portable communication device, a plate defining a rear surface of the portable communication device and including a nonconductive material, wherein the plate is configured to have a first surface facing an outside of the portable communication device and a second surface facing an inside of the portable communication device, an antenna disposed in or attached to a first area of the second surface or disposed adjacent to the first area, an electronic component disposed in or attached to a second area of the second surface, and a conductive member disposed in or attached to a third area between the first area and the second area, wherein the conductive member at least partially interrupts some electric waves, among electric waves radiated from the antenna, that travel toward the electronic component through the plate.

According to various embodiments of the disclosure, the antenna performance of an antenna module may be secured by reducing an electrical influence, by a structure such as a housing, on the antenna radiation characteristics (e.g., a polarization state of a beam pattern or electromagnetic waves). According to various embodiments of the disclosure, an electrical influence, by electromagnetic waves formed in an antenna module, on another electrical element through a structure can be reduced, and thus the performance of the other electrical element can be secured.

In addition, the effects that may be obtained or expected by various embodiments of the disclosure will be directly or implicitly disclosed in a detailed description of the embodiments of the disclosure. For example, various effects expected according to various embodiments of the disclosure will be disclosed in the detailed description of the disclosure, which will be described below.

Other aspects, advantages, and salient features of the disclosure will become apparent to those skilled in the art from the following detailed description, which, taken in conjunction with the annexed drawings, discloses various embodiments of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of certain embodiments of the disclosure will be more apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a block diagram of an electronic device in a network environment according to an embodiment of the disclosure;

FIG. **2** is a block diagram of an electronic device in a network environment including a plurality of cellular networks according to an embodiment of the disclosure;

FIG. **3**A is a front perspective view of a mobile electronic device according to an embodiment of the disclosure;

FIG. **3**B is a rear perspective view of the electronic device of FIG. **3**A according to an embodiment of the disclosure;

FIG. **4** is an exploded perspective view of an electronic device according to an embodiment of the disclosure;

FIG. **5**A illustrates an electronic device including an antenna module according to an embodiment of the disclosure, and FIG. **5**B illustrates an electronic device including an antenna module according to an embodiment of the disclosure;

FIG. **6** is a view of the electronic device of FIG. **5**A viewed from the top of a rear plate according to an embodiment of the disclosure;

FIG. **7**A is a perspective view of an antenna module according to an embodiment of the disclosure, and FIG. **7**B is a perspective view of an antenna module according to an embodiment of the disclosure;

FIG. **8** is a perspective view of the electronic device of FIG. **5**A according to an embodiment of the disclosure;

FIG. **9** is a cross-sectional view of the electronic device of FIG. **8** according to an embodiment of the disclosure;

FIG. **10** is a perspective view of the electronic device of FIG. **5**A according to an embodiment of the disclosure;

FIG. **11** illustrates a radiation pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure, and

FIG. **12** illustrates a radiation pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure;

FIG. **13** illustrates a radiation pattern for vertically polarized waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure, and

FIG. **14** illustrates a radiation pattern for vertically polarized waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure;

FIG. **15** illustrates a beam pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure, and FIG. **16** illustrates a beam pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure;

FIG. **17** illustrates a beam pattern for vertically polarized waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure, and

FIG. **18** illustrates a beam pattern for vertically polarized waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure;

FIG. **19** is a cross-sectional view of an electronic device including an antenna module according to an embodiment of the disclosure;

FIG. **20** is a perspective view, for example, of the electronic device of FIG. **19**, according to an embodiment of the disclosure;

FIG. **21** illustrates a beam pattern for electromagnetic waves radiated from an antenna module in the electronic device of FIG. **19** or **20** according to an embodiment of the disclosure;

FIG. **22** illustrates a beam pattern for electromagnetic waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **19** or **20**, according to an embodiment of the disclosure;

FIG. **23** is a graph depicting an antenna gain in a frequency distribution in the electronic device of FIG. **19**, **20**, or **22** according to an embodiment of the disclosure;

FIG. **24** is a cross-sections of an electronic device, taken along line I-I of FIG. **6**, according to an embodiment of the disclosure,

FIG. **25** is a cross-sections of an electronic device, taken along line I-I of FIG. **6**, according to an embodiment of the disclosure, and

FIG. **26** is a cross-sections of an electronic device, taken along line I-I of FIG. **6** according to an embodiment of the disclosure;

FIG. **27** illustrates an electronic device including an antenna module seated in a mid-frame according to an embodiment of the disclosure;

FIG. **28** is a cross-sectional view of the electronic device of FIG. **27**, taken along line II-II, according to an embodiment of the disclosure;

FIG. **29** illustrates an electronic device including a conductive layer of a mid-frame and a conductive layer attached to a rear frame according to an embodiment of the disclosure; and

FIG. **30** is a cross-sectional view of the electronic device of FIG. **29**, taken along line III-III, according to an embodiment of the disclosure.

Throughout the drawings, it should be noted that like reference numbers are used to depict the same or similar elements, features, and structures.

DETAILED DESCRIPTION

The following description with reference to the accompanying drawings is provided to assist in a comprehensive understanding of various embodiments of the disclosure as defined by the claims and their equivalents. It includes various specific details to assist in that understanding but these are to be regarded as merely exemplary. Accordingly, those of ordinary skill in the art will recognize that various changes and modifications of the various embodiments described herein can be made without departing from the scope and spirit of the disclosure. In addition, descriptions of well-known functions and constructions may be omitted for clarity and conciseness.

The terms and words used in the following description and claims are not limited to the bibliographical meanings, but, are merely used by the inventor to enable a clear and consistent understanding of the disclosure. Accordingly, it should be apparent to those skilled in the art that the following description of various embodiments of the disclosure is provided for illustration purpose only and not for the purpose of limiting the disclosure as defined by the appended claims and their equivalents.

It is to be understood that the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to "a component surface" includes reference to one or more of such surfaces.

FIG. **1** is a block diagram illustrating an electronic device **101** in a network environment **100** according to an embodiment of the disclosure.

Referring to FIG. **1**, the electronic device **101** in the network environment **100** may communicate with an electronic device **102** via a first network **198** (e.g., a short-range wireless communication network), or an electronic device **104** or a server **108** via a second network **199** (e.g., a long-range wireless communication network). According to an embodiment, the electronic device **101** may communicate with the electronic device **104** via the server **108**. According to an embodiment, the electronic device **101** may include a processor **120**, memory **130**, an input device **150**, a sound output device **155**, a display device **160**, an audio module **170**, a sensor module **176**, an interface **177**, a haptic module **179**, a camera module **180**, a power management module **188**, a battery **189**, a communication module **190**, a subscriber identification module (SIM) **196**, or an antenna module **197**. In some embodiments, at least one (e.g., the display device **160** or the camera module **180**) of the components may be omitted from the electronic device **101**, or one or more other components may be added in the electronic device **101**. In some embodiments, some of the components may be implemented as single integrated circuitry. For example, the sensor module **176** (e.g., a fingerprint sensor, an iris sensor, or an illuminance sensor) may be implemented as embedded in the display device **160** (e.g., a display).

The processor **120** may execute, for example, software (e.g., a program **140**) to control at least one other component (e.g., a hardware or software component) of the electronic device **101** coupled with the processor **120**, and may perform various data processing or computation. According to one embodiment, as at least part of the data processing or computation, the processor **120** may load a command or data received from another component (e.g., the sensor module **176** or the communication module **190**) in volatile memory **132**, process the command or the data stored in the volatile memory **132**, and store resulting data in non-volatile memory **134**. According to an embodiment, the processor **120** may include a main processor **121** (e.g., a central processing unit (CPU) or an application processor (AP)), and an auxiliary processor **123** (e.g., a graphics processing unit (GPU), an image signal processor (ISP), a sensor hub processor, or a communication processor (CP)) that is operable independently from, or in conjunction with, the main processor **121**. Additionally or alternatively, the auxiliary processor **123** may be adapted to consume less power than the main processor **121**, or to be specific to a specified function. The auxiliary processor **123** may be implemented as separate from, or as part of the main processor **121**.

The auxiliary processor **123** may control at least some of functions or states related to at least one component (e.g., the display device **160**, the sensor module **176**, or the communication module **190**) among the components of the electronic device **101**, instead of the main processor **121** while the main processor **121** is in an inactive (e.g., sleep) state, or together with the main processor **121** while the main processor **121** is in an active state (e.g., executing an application). According to an embodiment, the auxiliary processor **123** (e.g., an image signal processor or a communication processor) may be implemented as part of another component (e.g., the camera module **180** or the communication module **190**) functionally related to the auxiliary processor **123**.

The memory **130** may store various data used by at least one component (e.g., the processor **120** or the sensor module **176**) of the electronic device **101**. The various data may include, for example, software (e.g., the program **140**) and input data or output data for a command related thereto. The memory **130** may include the volatile memory **132** or the non-volatile memory **134**.

The program **140** may be stored in the memory **130** as software, and may include, for example, an operating system (OS) **142**, middleware **144**, or an application **146**.

The input device **150** may receive a command or data to be used by another component (e.g., the processor **120**) of the electronic device **101**, from the outside (e.g., a user) of the electronic device **101**. The input device **150** may include, for example, a microphone, a mouse, a keyboard, or a digital pen (e.g., a stylus pen).

The sound output device **155** may output sound signals to the outside of the electronic device **101**. The sound output device **155** may include, for example, a speaker or a receiver. The speaker may be used for general purposes, such as playing multimedia or playing record, and the receiver may be used for an incoming call. According to an embodiment, the receiver may be implemented as separate from, or as part of the speaker.

The display device **160** may visually provide information to the outside (e.g., a user) of the electronic device **101**. The display device **160** may include, for example, a display, a hologram device, or a projector and control circuitry to control a corresponding one of the display, hologram device, and projector. According to an embodiment, the display device **160** may include touch circuitry adapted to detect a touch, or sensor circuitry (e.g., a pressure sensor) adapted to measure the intensity of force incurred by the touch.

The audio module **170** may convert a sound into an electrical signal and vice versa. According to an embodiment, the audio module **170** may obtain the sound via the input device **150**, or output the sound via the sound output device **155** or a headphone of an external electronic device (e.g., an electronic device **102**) directly (e.g., wiredly) or wirelessly coupled with the electronic device **101**.

The sensor module **176** may detect an operational state (e.g., power or temperature) of the electronic device **101** or an environmental state (e.g., a state of a user) external to the electronic device **101**, and then generate an electrical signal or data value corresponding to the detected state. According to an embodiment, the sensor module **176** may include, for example, a gesture sensor, a gyro sensor, an atmospheric pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a proximity sensor, a color sensor, an infrared (IR) sensor, a biometric sensor, a temperature sensor, a humidity sensor, or an illuminance sensor.

The interface **177** may support one or more specified protocols to be used for the electronic device **101** to be coupled with the external electronic device (e.g., the electronic device **102**) directly (e.g., wiredly) or wirelessly. According to an embodiment, the interface **177** may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, a secure digital (SD) card interface, or an audio interface.

A connecting terminal **178** may include a connector via which the electronic device **101** may be physically connected with the external electronic device (e.g., the electronic device **102**). According to an embodiment, the connecting terminal **178** may include, for example, a HDMI connector, a USB connector, a SD card connector, or an audio connector (e.g., a headphone connector).

The haptic module **179** may convert an electrical signal into a mechanical stimulus (e.g., a vibration or a movement) or electrical stimulus which may be recognized by a user via his tactile sensation or kinesthetic sensation. According to an embodiment, the haptic module **179** may include, for example, a motor, a piezoelectric element, or an electric stimulator.

The camera module **180** may capture a still image or moving images. According to an embodiment, the camera module **180** may include one or more lenses, image sensors, image signal processors, or flashes.

The power management module **188** may manage power supplied to the electronic device **101**. According to one embodiment, the power management module **188** may be implemented as at least part of, for example, a power management integrated circuit (PMIC).

The battery **189** may supply power to at least one component of the electronic device **101**. According to an embodiment, the battery **189** may include, for example, a primary cell which is not rechargeable, a secondary cell which is rechargeable, or a fuel cell.

The communication module **190** may support establishing a direct (e.g., wired) communication channel or a wireless communication channel between the electronic device **101** and the external electronic device (e.g., the electronic device **102**, the electronic device **104**, or the server **108**) and performing communication via the established communication channel. The communication module **190** may include one or more communication processors that are operable independently from the processor **120** (e.g., the application processor (AP)) and supports a direct (e.g., wired) communication or a wireless communication. According to an embodiment, the communication module **190** may include a wireless communication module **192** (e.g., a cellular communication module, a short-range wireless communication module, or a global navigation satellite system (GNSS) communication module) or a wired communication module **194** (e.g., a local area network (LAN) communication module or a power line communication (PLC) module). A corresponding one of these communication modules may communicate with the external electronic device via the first network **198** (e.g., a short-range communication network, such as Bluetooth™, Wi-Fi direct, or infrared data association (IrDA)) or the second network **199** (e.g., a long-range communication network, such as a cellular network, the Internet, or a computer network (e.g., LAN or wide area network (WAN)). These various types of communication modules may be implemented as a single component (e.g., a single chip), or may be implemented as multi components (e.g., multi chips) separate from each other. The wireless communication module **192** may identify and authenticate the electronic device **101** in a communication network, such as the first network **198** or the second network **199**, using subscriber information (e.g., international mobile subscriber identity (IMSI)) stored in the SIM **196**.

The antenna module **197** may transmit or receive a signal or power to or from the outside (e.g., the external electronic device) of the electronic device **101**. According to an embodiment, the antenna module **197** may include an antenna including a radiating element composed of a conductive material or a conductive pattern formed in or on a substrate (e.g., PCB). According to an embodiment, the antenna module **197** may include a plurality of antennas. In such a case, at least one antenna appropriate for a communication scheme used in the communication network, such as the first network **198** or the second network **199**, may be selected, for example, by the communication module **190** (e.g., the wireless communication module **192**) from the plurality of antennas. The signal or the power may then be transmitted or received between the communication module **190** and the external electronic device via the selected at least one antenna. According to an embodiment, another component (e.g., a radio frequency (RF) integrated circuit (RFIC)) other than the radiating element may be additionally formed as part of the antenna module **197**.

At least some of the above-described components may be coupled mutually and communicate signals (e.g., commands or data) therebetween via an inter-peripheral communication scheme (e.g., a bus, general purpose input and output (GPIO), serial peripheral interface (SPI), or mobile industry processor interface (MIPI)).

According to an embodiment, commands or data may be transmitted or received between the electronic device **101** and the external electronic device **104** via the server **108** coupled with the second network **199**. Each of the electronic devices **102** and **104** may be a device of a same type as, or a different type, from the electronic device **101**. According to an embodiment, all or some of operations to be executed at the electronic device **101** may be executed at one or more of the external electronic devices **102**, **104**, or **108**. For example, if the electronic device **101** should perform a function or a service automatically, or in response to a request from a user or another device, the electronic device **101**, instead of, or in addition to, executing the function or the service, may request the one or more external electronic devices to perform at least part of the function or the service. The one or more external electronic devices receiving the request may perform the at least part of the function or the service requested, or an additional function or an additional service related to the request, and transfer an outcome of the performing to the electronic device **101**. The electronic device **101** may provide the outcome, with or without further processing of the outcome, as at least part of a reply to the request. To that end, a cloud computing, distributed computing, or client-server computing technology may be used, for example.

The electronic device according to various embodiments may be one of various types of electronic devices. The electronic devices may include, for example, a portable communication device (e.g., a smartphone), a computer device, a portable multimedia device, a portable medical device, a camera, a wearable device, or a home appliance. According to an embodiment of the disclosure, the electronic devices are not limited to those described above.

It should be appreciated that various embodiments of the disclosure and the terms used therein are not intended to limit the technological features set forth herein to particular embodiments and include various changes, equivalents, or replacements for a corresponding embodiment. With regard to the description of the drawings, similar reference numerals may be used to refer to similar or related elements. It is to be understood that a singular form of a noun corresponding to an item may include one or more of the things, unless the relevant context clearly indicates otherwise. As used herein, each of such phrases as "A or B," "at least one of A and B," "at least one of A or B," "A, B, or C," "at least one of A, B, and C," and "at least one of A, B, or C," may include any one of, or all possible combinations of the items enumerated together in a corresponding one of the phrases. As used herein, such terms as "1st" and "2nd," or "first" and "second" may be used to simply distinguish a corresponding component from another, and does not limit the components in other aspect (e.g., importance or order). It is to be understood that if an element (e.g., a first element) is referred to, with or without the term "operatively" or "communicatively," as "coupled with," "coupled to," "connected with," or "connected to" another element (e.g., a second element), it means that the element may be coupled with the other element directly (e.g., wiredly), wirelessly, or via a third element.

As used herein, the term "module" may include a unit implemented in hardware, software, or firmware, and may interchangeably be used with other terms, for example, "logic," "logic block," "part," or "circuitry." A module may be a single integral component, or a minimum unit or part thereof, adapted to perform one or more functions. For example, according to an embodiment, the module may be implemented in a form of an application-specific integrated circuit (ASIC).

Various embodiments as set forth herein may be implemented as software (e.g., the program **140**) including one or more instructions that are stored in a storage medium (e.g., internal memory **136** or external memory **138**) that is readable by a machine (e.g., the electronic device **101**). For example, a processor (e.g., the processor **120**) of the machine (e.g., the electronic device **101**) may invoke at least one of the one or more instructions stored in the storage medium, and execute it, with or without using one or more other components under the control of the processor. This allows the machine to be operated to perform at least one function according to the at least one instruction invoked. The one or more instructions may include a code generated by a complier or a code executable by an interpreter. The machine-readable storage medium may be provided in the form of a non-transitory storage medium. Wherein, the term "non-transitory" simply means that the storage medium is a tangible device, and does not include a signal (e.g., an electromagnetic wave), but this term does not differentiate between where data is semi-permanently stored in the storage medium and where the data is temporarily stored in the storage medium.

According to an embodiment, a method according to various embodiments of the disclosure may be included and provided in a computer program product. The computer program product may be traded as a product between a seller and a buyer. The computer program product may be distributed in the form of a machine-readable storage medium (e.g., compact disc read only memory (CD-ROM)), or be distributed (e.g., downloaded or uploaded) online via an application store (e.g., PlayStore™), or between two user devices (e.g., smart phones) directly. If distributed online, at least part of the computer program product may be temporarily generated or at least temporarily stored in the machine-readable storage medium, such as memory of the manufacturer's server, a server of the application store, or a relay server.

According to various embodiments, each component (e.g., a module or a program) of the above-described components may include a single entity or multiple entities. According to various embodiments, one or more of the above-described components may be omitted, or one or more other components may be added. Alternatively or additionally, a plurality of components (e.g., modules or programs) may be integrated into a single component. In such a case, according to various embodiments, the integrated component may still perform one or more functions of each of the plurality of components in the same or similar manner as they are performed by a corresponding one of the plurality of components before the integration. According to various embodiments, operations performed by the module, the program, or another component may be carried out sequentially, in parallel, repeatedly, or heuristically, or one or more of the operations may be executed in a different order or omitted, or one or more other operations may be added.

FIG. **2** is a block diagram **200** illustrating an example electronic device **101** in a network environment including multiple cellular networks according to an embodiment of the disclosure.

Referring to FIG. **2**, the electronic device **101** may include a first communication processor (e.g., including processing circuitry) **212**, a second communication processor (e.g., including processing circuitry) **214**, a first RFIC **222**, a second RFIC **224**, a third RFIC **226**, a fourth RFIC **228**, a first radio frequency front end (RFFE) (e.g., including radio frequency circuitry) **232**, a second RFFE (e.g., including radio frequency circuitry) **234**, a first antenna module (e.g., including an antenna) **242**, a second antenna module (e.g., including an antenna) **244**, and an antenna **248**. The electronic device **101** may further include a processor (e.g., including processing circuitry) **120** and memory **130**. The second network **199** may include a first cellular network **292** and a second cellular network **294**. According to another embodiment, the electronic device **101** may further include at least one of the components illustrated in FIG. **2**, and the second network **199** may further include at least one other network. According to an embodiment, the first communication processor **212**, the second communication processor **214**, the first RFIC **222**, the second RFIC **224**, the fourth RFIC **228**, the first RFFE **232**, and the second RFFE **234** may comprise at least a part of a wireless (e.g., RF) communication module **192**. According to another embodiment, the fourth RFIC **228** may be omitted, or may be included as a part of the third RFIC **226**.

According to various embodiments, the first communication processor **212** may include various communication processing circuitry and establish a communication channel in a band to be used for RF communication with the first cellular network **292**, and may support legacy network communication over the established communication channel. According to various embodiments, the first cellular network may be a legacy network including, for example, and without limitation, a second generation (2G), 3G, 4G, long-term-evolution (LTE) network, or the like. The second communication processor **214** may include various communication processing circuitry and establish a communication channel corresponding to a designated band (e.g., about 6 GHz to about 60 GHz) in a band to be used for RF communication with the second cellular network **294**, and may support 5G network communication through the established communication channel According to various embodiments, the second cellular network **294** may, for example, and without limitation, be a 5G network defined in the 3GPP. In addition, according to an embodiment, the first communication processor **212** and/or the second communication processor **214** may establish a communication channel corresponding to another designated band (e.g., about 6 GHz or lower) in the band to be used for RF communication with the second cellular network **294**, and may support 5G network communication through the established communication channel According to an embodiment, the first communication processor **212** and the second communication processor **214** may be implemented in a single chip or in a single package. According to various embodiments, the first communication processor **212** and/or the second communication processor **214** may be formed in a single chip or a single package with the processor **120**, an auxiliary processor **123**, and/or a communication module **190**.

According to an embodiment, during transmission, the first RFIC **222** may convert a baseband signal generated by the first communication processor **212** into an RF signal ranging, for example, from about 700 MHz to about 3 GHz to be used in the first cellular network **292** (e.g., a legacy network). During reception, an RF signal may be acquired from the first cellular network **292** (e.g., the legacy network) through an antenna (e.g., the first antenna module **242**) and may be pre-processed through an RFFE (e.g., the first RFFE **232**). The first RFIC **222** may convert the pre-processed RF signal into a baseband signal to be processed by the first communication processor **212**.

According to an embodiment, during transmission, the second RFIC **224** may convert the baseband signal generated by the first communication processor **212** and/or the second communication processor **214** into an RF signal in, for example, a Sub6 band (e.g., about 6 GHz or lower) (hereinafter, referred to as "5G Sub6 RF signal") to be used in the second cellular network **294** (e.g., a 5G network). During reception, the 5G Sub6 RF signal may be acquired from the second cellular network **294** (e.g., a 5G network) through an antenna (e.g., the second antenna module **244**), and may be pre-processed through an RFFE (e.g., the second RFFE **234**). The second RFIC **224** may convert the pre-processed 5G Sub6 RF signal into a baseband signal so as to be processed by a corresponding one of the first communication processor **212** and the second communication processor **214**.

According to an embodiment, the third RFIC **226** may convert the baseband signal generated by the second communication processor **214** into an RF signal in a 5G Above6 band (e.g., about 6 GHz to about 60 GHz) (hereinafter, referred to as "5G Above6 RF signal") to be used in the second cellular network **294** (e.g., a 5G network). During reception, the 5G Above6 RF signal may be acquired from the second cellular network **294** (e.g., a 5G network) through an antenna (e.g., the second antenna module **244**), and may be pre-processed through the third RFFE **236**. The third RFIC **226** may convert the pre-processed 5G Above6 RF signal into a baseband signal to be processed by the second communication processor **214**. According to an embodiment, the third RFFE **236** may be formed as a part of the third RFIC **226**.

According to an embodiment, the electronic device **101** may include a fourth RFIC **228** separately from or as at least a part of the third RFIC **226**. In this case, the fourth RFIC **228** may convert a baseband signal generated by the second communication processor **214** into an RF signal (hereinafter, referred to as "IF signal") in an intermediate frequency band (e.g., about 9 GHz to about 11 GHz), and may then deliver the IF signal to the third RFIC **226**. The third RFIC **226** may convert the IF signal into a 5G Above6 RF signal. During reception, the 5G Above6 RF signal may be acquired from the second cellular network **294** (e.g., a 5G network) through an antenna (e.g., the antenna **248**), and may be configured into an IF signal through the third RFIC **226**. The fourth RFIC **228** may convert the IF signal into a baseband signal to be processed by the second communication processor **214**.

According to an embodiment, the first RFIC **222** and the second RFIC **224** may be implemented as at least a part of a single chip or a single package. According to an embodiment, the first RFFE **232** and the second RFFE **234** may be implemented as at least a part of a single chip or a single package. According to an embodiment, at least one of the first antenna module **242** and the second antenna module **244** may be omitted or combined with another antenna module so as to process RF signals of multiple corresponding bands.

According to an embodiment, the third RFIC **226** and the antenna **248** may be disposed on the same substrate to comprise a third antenna module **246**. For example, the wireless (e.g., RF) communication module **192** and/or the processor **120** may be placed on a first substrate (e.g., a main PCB). In such a case, the third RFIC **226** may be disposed on a partial area (e.g., a lower face) of a second substrate (e.g., a sub-PCB) separate from the first substrate, and the antenna **248** may be disposed on another partial area (e.g., an upper face), thereby forming the third antenna module **246**. By disposing the third RFIC **226** and the antenna **248** on the same substrate, it is possible to reduce the length of the transmission line therebetween. Thus, it may be possible to reduce the loss (e.g., attenuation) of a signal in an RF band (e.g., about 6 GHz to about 60 GHz) to be used, for example, for 5G network communication by the transmission line. As a result, the electronic device **101** is able to improve the quality or speed of communication with the second cellular network **294** (e.g., a 5G network).

According to an embodiment, the antenna **248** may be an antenna array including multiple antenna elements that are capable of being used for beamforming. In this case, the third RFIC **226** may include multiple phase shifters (i.e., phase converters) **238** corresponding to the multiple antenna elements, for example, as a part of the third RFFE **236**. During transmission, each of the multiple phase shifters **238** may convert the phase of a 5G Above6 RF signal to be transmitted to the outside of the electronic device **101** (e.g., a base station of a 5G network) through a corresponding antenna element. During reception, each of the multiple phase shifters **238** may convert the phase of the 5G Above6 RF signal received from the outside into the same or substantially the same phase through the corresponding antenna element. This enables transmission or reception through beamforming between the electronic device **101** and the outside.

According to various embodiments, the second cellular network **294** (e.g., a 5G network) may be operated independently from the first cellular network **292** (e.g., a legacy network) (e.g., Stand-Alone (SA)), or may be operated in the state of being connected to the first cellular network **292** (e.g., Non-Stand Alone (NSA)). For example, in a 5G network, only an access network (e.g., a 5G radio access network (RAN) or a next-generation RAN (NG RAN)) may exist but a core network (e.g., a next-generation core (NGC)) may not exist. In this case, after accessing the access network of the 5G network, the electronic device **101** may access an external network (e.g., the Internet) under the control of the core network (e.g., an evolved packet core (EPC)) of a legacy network. Protocol information for communication with a legacy network (e.g., LTE protocol information) or protocol information for communication with a 5G network (e.g., new radio (NR) protocol information) may be stored in the memory **230**, and may be accessed by another component (e.g., the processor **120**, the first communication processor **212**, or the second communication processor **214**).

FIG. **3**A is a perspective view illustrating a front side of an example mobile electronic device according to an embodiment of the disclosure, FIG. **3**B is a perspective view illustrating a back side of an example electronic device of FIG. **3**A according to an embodiment of the disclosure.

FIG. **3**A is a front perspective view illustrating an example mobile electronic device according to an embodiment of the disclosure.

FIG. **3**B is a rear perspective view illustrating an example mobile electronic device of FIG. **3**A according to an embodiment of the disclosure.

Referring to FIGS. **3**A and **3**B, an electronic device **300** according to an embodiment may include a housing **310** including a first side (or a front side) **310**A, a second side (or a rear side) **310**B, and a lateral side (surface) **310**C surrounding a space between the first side **310**A and the second side **310**B. In another embodiment (not shown), the housing may refer to a structure which includes part of the first side **310**A, the second side **310**B, and the third side **310**C of FIGS. **3**A and **3**B.

According to an embodiment, the first side **310**A may be constructed of a front plate **302** (or a front cover) (e.g., a polymer plate or a glass plate having various coating layers) which is at least partially transparent. The front plate **302** may include a curved portion that extends smoothly from at least one side edge portion toward the rear plate **311** from the first surface **310**A.

The second side **310**B may be constructed of a rear plate **311** (or a rear cover) which may be opaque. The rear plate **311** may be constructed, for example, and without limitation, of coated or colored glass, ceramic, polymer, metallic materials (e.g. aluminum, stainless steel (STS), or magnesium), a combination of at least two of these materials, or the like. According to an embodiment, the rear plate **311** may include a curved portion that is bent toward the front plate **302** from the second side **310**B at at least one end portion and extends seamlessly.

The lateral side **310**C (or a side member or side surface) may be constructed of a side (e.g., lateral) bezel structure (or a lateral member) **318** bonded to the front plate **302** and the rear plate **311** and including, for example, and without limitation, metal and/or polymer. In some embodiments, the rear plate **311** and the side (lateral) bezel structure **318** may be constructed integrally and may include the same material (e.g., a metallic material such as aluminum).

According to various embodiments, the electronic device **300** may include at least one of a display **301**, an audio module corresponding to an audio module hole **303**, **314**, a sensor module, a camera module **305**, a key input device **317**, and a connector hole **308**. It may include the above. In some embodiments, the electronic device **300** may omit at least one of the components (for example, the key input device **317**) or additionally include other components. For example, the electronic device **300** may include a sensor module (not shown). For example, within an area provided by the front plate **302**, a sensor such as a proximity sensor or an illuminance sensor may be integrated into the display **301**, or may be disposed at a position adjacent to the display **301**. In some embodiments, the electronic device **300** may further include a light-emitting device, and the light-emitting device may be disposed at a position adjacent to the display **301** within an area provided by the front plate **302**. The light-emitting device may provide, for example, status information of the electronic device **300** in the form of light. In another embodiment, the light-emitting device may provide, for example, a light source interlocked with the operation of the camera module **305**. The light-emitting element may include, for example, an LED, an IR LED, and a xenon lamp.

The display **301** can be exposed, for example, through a significant portion of the front plate **302**. In some embodiments, the edge of the display **301** may be formed to be substantially the same as the adjacent outer shape (e.g., a curved surface) of the front plate **302**. In another embodiment (not shown), in order to expand the area where the display **301** is exposed, the distance between the outer edge of the display **301** and the outer edge of the front plate **302** may be substantially the same. In another embodiment (not shown), a recess or opening is formed in a part of a screen display area of the display **301**, and other electronic components aligned with the recess or the opening, for example, may include a camera module **305**, a proximity sensor (not shown) or an illuminance sensor.

In another embodiment (not shown), at least one of the camera modules **312** and **313**, the fingerprint sensor **316**, and the flash **306** may be included on the rear surface of the screen display area of the display **301**. In another embodiment (not shown), the display **301** is coupled to or adjacent to a touch sensing circuit, a pressure sensor capable of measuring the intensity (pressure) of the touch, and/or a digitizer detecting a magnetic field type stylus pen.

The audio modules located at holes **303** and **314** may include a microphone hole **303** and a speaker hole **314**. In the microphone hole **303**, a microphone for acquiring external sound may be arranged inside, and in some embodiments, a plurality of microphones may be arranged to sense the direction of sound. In some embodiments, a speaker hole and a microphone hole may be implemented as one hole **303**, or a speaker may be included without a speaker hole (e.g., a piezo speaker). The speaker hole may include an external speaker hole and a call receiver hole **314**.

The electronic device **300** may generate an electrical signal or data value corresponding to an internal operating state or an external environmental state by including a sensor module (not shown). The sensor module may be, for example, a proximity sensor disposed on the first surface **310**A of the housing **310**, a fingerprint sensor integrated or adjacent to the display **301**, and/or a product of the housing **310**. A biometric sensor (e.g., an HRM sensor) disposed on the two surfaces **310**A and **310**B may be further included. The electronic device **300** includes a sensor module (not shown), for example, a gesture sensor, a gyro sensor, an air pressure sensor, a magnetic sensor, an acceleration sensor, a grip sensor, a color sensor, an infrared (IR) sensor, a bio sensor, a temperature sensor, It may further include at least one of a humidity sensor or an illuminance sensor.

The camera modules **305**, **312**, and **313**, and flash **306** may include a first camera device **305** disposed on the first surface **310**A of the electronic device **300**, and a second camera device disposed on the second surface **310**B (e.g., cameras **312**, **313**, and/or flash **306**). The camera devices **305**, **312**, and **313** may include one or more lenses, an image sensor, and/or an image signal processor. The flash **306** may include, for example, a light-emitting diode or a xenon lamp. In some embodiments, two or more lenses (infrared camera, wide-angle and telephoto lenses) and image sensors may be disposed on one side of the electronic device **300**.

The key input device **317** may be disposed on the side surface **310**C of the housing **310**. In another embodiment, the electronic device **300** may not include some or all of the key input devices **317** mentioned above, and the key input devices **317** that are not included may include other soft keys on the display **301**. It can be implemented in the form. In some embodiments, the key input device can include at least a portion of the fingerprint sensor **316** disposed on the second side **310**B of the housing **310**.

The connector hole **308** may accommodate a connector for transmitting and receiving power and/or data to and from the external electronic device, and/or a connector for transmitting and receiving audio signals to and from the external electronic device. For example, the connector hole **308** may include a USB connector or an earphone jack.

FIG. **4** is an exploded perspective view of an electronic device according to an embodiment of the disclosure.

Referring to FIG. **4**, the electronic device **400** according to an embodiment (e.g., the electronic device **300** of FIG. **3**A or **3**B) includes a side bezel structure **410** (e.g., the side bezel structure **318** of FIG. **3**A)), first support member **411** (e.g., a bracket), front plate **420** (e.g., front plate **302** in FIG. **3**A), display **430** (e.g., display **301** in FIG. **3**A)), printed circuit board **440**, battery **450**, second support member **460** (e.g., rear case), antenna **470**, or rear plate **480** (e.g., rear plate **311** in FIG. **3**B)). In some embodiments, the electronic device **400** may omit at least one of the components (e.g., the first support member **411** or the second support member **460**) or additionally include other components. At least one of the components of the electronic device **400** may be the same or similar to at least one of the components of the electronic device **300** of FIG. **3**A or **3**B, and overlapping descriptions are omitted below.

The first support member **411** may be disposed inside the electronic device **400** and connected to the side bezel structure **410** or may be integrally formed with the side bezel structure **410**. The first support member **411** may be formed of, for example, a metal material and/or a non-metal (e.g., polymer) material. In the first support member **411**, a display **430** may be coupled to one surface and a printed circuit board **440** may be coupled to the other surface. The printed circuit board **440** may be equipped with a processor, memory, and/or interface. The processor may include, for example, one or more of a central processing unit, an application processor, a graphic processing unit, an image signal processor, a sensor hub processor, or a communication processor.

The memory may include, for example, volatile memory or nonvolatile memory.

The interface may include, for example, a high definition multimedia interface (HDMI), a universal serial bus (USB) interface, an SD card interface, and/or an audio interface. The interface may electrically or physically connect the electronic device **400** to an external electronic device, for example, and include a USB connector, an SD card/MMC connector, or an audio connector.

The battery **450** is, for example, a device for supplying power to at least one component of the electronic device **400**, for example, a non-rechargeable primary cell, or a rechargeable secondary cell, or a fuel cell it may include. At least a portion of the battery **450** may be disposed, for example, on a substantially coplanar surface with the printed circuit board **440**. The battery **450** may be integrally disposed within the electronic device **400** or may be detachably disposed with the electronic device **400**.

The antenna **470** may be disposed between the rear plate **480** and the battery **450** in one embodiment. The antenna **470** may include, for example, a near field communication (NFC) antenna, a wireless charging antenna, and/or a magnetic secure transmission (MST) antenna. The antenna **470** may, for example, perform short-range communication with an external device or wirelessly transmit and receive power required for charging. In another embodiment, the antenna structure may be formed by a side bezel structure **410** and/or a portion of the first support member **411** or a combination thereof.

FIG. **5**A illustrates an electronic device including an antenna module according to an embodiment of the disclosure, and FIG. **5**B illustrates an electronic device including an antenna module according to an embodiment of the disclosure.

FIG. **6** is a view of the electronic device of FIG. **5**A viewed from the top of a rear plate according to an embodiment of the disclosure.

FIG. **7**A is a perspective view of an antenna module according to an embodiment of the disclosure, and FIG. **7**B is a perspective view of an antenna module according to an embodiment of the disclosure.

Referring to FIG. **5**A, an electronic device **500** (e.g., the electronic device **101** of FIG. **1** or **2**, the electronic device **300** of FIG. **3**A, or the electronic device **400** of FIG. **4**) may include a side bezel structure **510**, a rear plate **580**, an antenna module (or an antenna structure) **610**, a second printed circuit board **540**, or a conductive layer (or a conductive film) **620***a*.

At least one of the components of the electronic device **500** may be the same as or similar to at least one of the components of the electronic device **300** of FIG. **3**A or **3**B or the electronic device **400** of FIG. **4**, and a repeated description thereof will be omitted hereinafter.

Referring to FIGS. **5**A, **5**B, and **6**, in an embodiment, the side bezel structure **510** (e.g., the side bezel structure **318** of FIG. **3**A or the side bezel structure **410** of FIG. **4**) may include a first side surface part **511**, a second side surface part **512**, a third side surface part **513**, and a fourth side surface part **514**. The first side surface part **511** and the second side surface part **512** may be disposed on opposite sides and may be parallel to each other. The third side surface part **513** and the fourth side surface part **514** may be disposed on opposite sides and may be parallel to each other. The third side surface part **513** may be perpendicular to the first side surface part **511** (or the second side surface part **512**), and may connect one end (not illustrated) of the first side surface part **511** and one end (not illustrated) of the second side surface part **512**. The fourth side surface part **514** may be perpendicular to the first side surface part **511** (or the second side surface part **512**), and may connect an opposite end (not illustrated) of the first side surface part **511** and an opposite end (not illustrated) of the second side surface part **512**.

The first side surface part **511** may define a first side surface (not illustrated) of the electronic device **500**, and the second side surface part **512** may define a second side surface (not illustrated) of the electronic device **500**, which is disposed on an opposite side to the first side surface. The third side surface part **513** may define a third side surface (not illustrated) of the electronic device **500**, and the fourth side surface part **514** may define a fourth side surface (not illustrated) of the electronic device **500**, which is disposed on an opposite side to the third side surface.

For example, when viewed from the top of the rear plate **580**, the first side surface and the second side surface may have a first length extending in the y axis direction, and the third side surface and the fourth side surface may have a second length extending in the +x axis direction and that is smaller than the first length. A connection part (not illustrated) between the first side surface part **511** and the third side surface part **513**, a connection part (not illustrated) between the first side surface part **511** and the fourth side surface part **514**, a connection part (not illustrated) between the second side surface part **512** and the third side surface part **513**, and/or a connection part (not illustrated) between the second side surface part **512** and the fourth side surface part **514** may define corners in the form of curves.

Referring to FIGS. **5**A, **5**B, **7**A, and **7**B, in an embodiment, the antenna module **610** (e.g., the second antenna module **244** or the third antenna module **246** of FIG. **2**) may include at least one of a first printed circuit board **611**, a first wireless communication circuit **730**, a power management circuit **740**, or a first connector **750**.

The first printed circuit board **611**, for example, may include a first surface **611***a*, and a second surface **611***b* disposed on an opposite side to the first surface **611***a*. According to an embodiment, the first printed circuit board **611** may be disposed between the rear plate **580** and the second printed circuit board **540** such that the first surface **611***a* faces the rear plate **580** and the second surface **611***b* faces the second printed circuit board **540**. The first printed circuit board **611** may be disposed to be parallel to the second printed circuit board **540**. For example, the first printed circuit board **611** may be directly soldered to the second printed circuit board **612**. As another example, the first printed circuit board **611** and the second printed circuit board **612** may be coupled to each other by an interposer (not illustrated) interposed between the first printed circuit board **611** and the second printed circuit board **612**. As another example, the first printed circuit board **611** may disposed on one surface of the second printed circuit board **612**, and may be connected to the second printed circuit board **612** by a separate cable.

Referring to FIG. **6**, in an embodiment, the antenna module **610** may be disposed closer to the third side surface part **513** than to the fourth side surface part **514**. According to an embodiment, the antenna module **610** may be disposed closer to the second side surface part **512** than to the first side surface part **511**. For example, the antenna module **610** may be disposed around a corner between the second side surface part **512** and the third side surface part **513**. Referring to FIG. **5**, in an embodiment, the antenna module **610** may be disposed around an opening **513***a* (e.g., the memory card connector of FIG. **9** (e.g., the SIM card connector **595**)) disposed in the third side surface part **513**.

According to various embodiments (not illustrated), the antenna module **610** may be disposed at other various locations. For example, the antenna module **610** may be disposed closer to the fourth side surface part **514** than to the third side surface part **513**. For example, the antenna module **610** may be disposed closer to the first side surface part **511** than to the second side surface part **512**. According to various embodiments (not illustrated), the antenna module **610** may be disposed around a corner between the first side surface part **511** and the third side surface part **513**, around a corner between the first side surface part **511** and the fourth side surface part **514**, or around a corner between the second side surface part **512** and the fourth side surface part **514**.

According to an embodiment, the first printed circuit board **611** may include one or more antennas. For example, the one or more antennas may be realized by at least some of a plurality of conductive layers (e.g., a plurality of conductive pattern layers or a plurality of circuit layers) included in the first printed circuit board **611**. According to an embodiment, the one or more antennas may include at least one of a first antenna array **710** or a second antenna array **720**. The first antenna array **710** or the second antenna array **720** may include a structure in which a plurality of antenna element having substantially the same form are arranged or a structure in which a plurality of antenna elements are arranged at a predetermined interval. According to various embodiments, the locations and the number of the antenna arrays are not limited to the example illustrated in FIG. **5**A, **5**B, or **7**A, and may be variously set. According to various embodiments, the locations or the number of the antenna elements included in the first antenna array **710** or the second antenna array **720** are not limited to the example illustrated in FIG. **5**A, **5**B, or **7**A, and may be variously set. According to another embodiment, the second antenna array **720** (e.g., a dipole antenna) may be omitted from the antenna module **610**. For example, the antenna module **610** may include only the first antenna array **710**.

The plurality of antenna elements included in the first antenna array **710** or the second antenna array **720**, for example, may include patch antennas, loop antennas, or dipole antennas. According to an embodiment, the plurality of antennas **711**, **712**, **713**, and **714** included in the first antenna array **710** may be patch antennas, and the plurality of antenna elements **721**, **722**, **723**, and **724** included in the second antenna array **720** may be dipole antennas. According to an embodiment, the plurality of antenna elements included in the first antenna array **710** and/or the second antenna array **720** may be electrically connected to the first wireless communication circuit **730**.

According to an embodiment, the first antenna array **710** and/or the second antenna array **720** may be disposed closer to the first surface **611***a* than to the second surface **611***b* or may be disposed on the first surface **611***a*. Referring to FIGS. **5**A, **5**B, **6**, and **7**A, in an embodiment, when viewed from the top of the rear plate **580** (e.g., the rear plate **311** of FIG. **3**B or the rear plate **480** of FIG. **4**), the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710** and the plurality of antenna elements **721**, **722**, **723**, and **724** of the second antenna array **720** may be arranged in a direction (e.g., the +x axis direction) facing the second side surface part **512** from the first side surface part **511**. According to an embodiment, when viewed from the top of the rear plate **520**, the second antenna array **720** may be disposed closer to the third side surface part **513** than to the first antenna array **710**.

Referring to FIGS. **7**A and **7**B, in an embodiment, the first wireless communication circuit **730** may be disposed on the second surface **611***b* of the first printed circuit board **611** through a conductive bonding member such as solder, and may be electrically connected to the first printed circuit board **611**. The first wireless communication circuit **730** may be electrically connected to the first antenna array **710** and the second antenna array **720** through wiring lines included in the first printed circuit board **611**. For example, the first wireless communication circuit **730** may include a circuit element (e.g., an RFIC) mounted on the first printed circuit board **611**.

According to an embodiment, the first wireless communication circuit **730** may transmit and/or receive a first signal of at least some frequency bands (e.g., a frequency band of about 24 GHz to about 100 GHz, a frequency band of about 24 GHz to about 30 GHz, or a frequency band of about 37 GHz to about 40 GHz), among about 6 GHz to about 100 GHz through the first antenna array **710** and/or the second antenna array **720**. According to an embodiment, the first wireless communication circuit **730** may up-convert or down-convert a frequency of a signal transmitted or received through wireless communication. Referring to FIGS. **5**A, **5**B, and **7**B, for example, the first wireless communication circuit **730** may receive an IF signal from a second wireless communication circuit **5022** of the second wireless communication module **502** disposed in the second printed circuit board **540**, and may up-convert the received IF signal to a radio frequency (RF) signal. For example, the first wireless communication circuit **730** may down-convert an RF signal (e.g., a millimeter wave) received through the first antenna array **710** or the second antenna array **720** to an IF signal, and the IF signal may be provided to the second wireless communication circuit **5022** disposed in the second printed circuit board **540**.

According to an embodiment, at least some of the plurality of conductive layers included in the first printed circuit board **611** may include a transmission line (e.g., an RF line) between one or more antenna arrays **710** and **720** and the first wireless communication circuit **730**. The transmission line is a structure for delivering a frequency signal (e.g., a voltage or a current), and may be referred to as a conductor system that uses an operation of delivering waves by an electrical medium parameter (e.g., a resistance, an inductance, a conductance, or a capacitance per unit length). For example, at least some of the plurality of conductive layers included in the first printed circuit board **611** may include an electrical path (or a wiring line) for supplying electric power to the one or more antenna arrays **710** and **720** between the one or more antenna arrays **710** and **720** and the first wireless communication circuit **730**.

According to an embodiment, the first connector **750** may be disposed on or coupled to the second surface **611***b* of the first printed circuit board **611** through a conductive bonding member such as solder, and may be electrically connected to the first printed circuit board **611**. The first connector **750** may be electrically connected to various other elements disposed in the first wireless communication circuit **730**, the power management circuit **740**, or the first printed circuit board **611** through at least one wiring line included in the first printed circuit board **611**. The electronic device **500**, for example, may include a second connector (not illustrated) mounted to the second printed circuit board **540**. According to an embodiment, the electronic device **500** may include an electrical path (not illustrated) such as a flexible printed circuit board (FPCB) or a coaxial cable that electrically connects the first connector **750** and the second connector.

Referring to FIG. **5**A, in an embodiment, the electronic device **500** may include a second wireless communication module **502** (e.g., the wireless communication module **192** of FIG. **1**) electrically connected to the second printed circuit board **540**, a processor **504** (e.g., the processor **120** of FIG. **1**), a memory **505** (e.g., the memory **130** of FIG. **1**), a power management module **506** (e.g., the power management module **188** of FIG. **1**), or at least one antenna **507**.

The second printed circuit board **540**, for example, may include a third surface **540***a* and a fourth surface (not illustrated) that face opposite directions. In an embodiment, referring to FIGS. **5**A, **5**B, **7**A, and **7**B, the second surface **611***b* of the first printed circuit board **611** may face the third surface **540***a* of the second printed circuit board **540**. The first wireless communication module **501**, the second wireless communication module **502**, the processor **504**, the power management module **506**, or the memory **505** may be disposed in or coupled to the second printed circuit board **540** through a conductive bonding member (not illustrated) such as solder.

According to an embodiment, at least one antenna **507** (e.g., the first antenna module **242** or the second antenna module **244** of FIG. **2**) may be electrically connected to the second printed circuit board **540** through various electrical paths. In some embodiments, the at least one antenna **507** may be disposed in the second printed circuit board **540** or may be realized in a conductive pattern (e.g., a micro-strip) included in the second printed circuit board **540**. According to various embodiments, the at least one antenna **507** may be disposed in a housing (not illustrated) that defines an external appearance of the electronic device **500** or may be realized by at least a portion (e.g., at least a portion of the side bezel structure **510**) of the housing.

According an embodiment, the processor **504** may control at least one element (e.g., a hardware or software element) of the electronic device **500** electrically connected to the processor **504** by executing software, and may perform various data processing or calculations. According to an embodiment, the processor **504** may process a command or data stored in the memory **505**. For example, the processor **504** may transmit and/or receive a signal through the first wireless communication module **501** or the second wireless communication module **502**. The processor **504** may write and read data to and from the memory **505**. The processor **504** may perform functions of a protocol stack required by communication standards. A portion of the second wireless communication module **502** and/or the processor **504** may be referred to as a communication processor (CP).

According to an embodiment, the second wireless communication module **502** may perform functions for transmitting and receiving a signal through a wireless channel. For example, the second wireless communication module **502** may perform a conversion function between a baseband signal and/or a bit array according to a physical layer standard of a system. For example, when data are transmitted, the second wireless communication module **502** may generate complex symbols by encoding and modulating a transmission bit array. When data are received, the second wireless communication module **502** may restore a bit array by decoding and demodulating a baseband signal. The second wireless communication module **502** may up-convert an RF signal and transmit the RF signal through at least one antenna, and may down-convert the RF signal received through the at least one antenna to a baseband signal. For example, the second wireless communication module **502** may include elements such as a transmission filter, a reception filter, an amplifier, a mixer, an oscillator, a digital-to-analog converter (DAC), and an analog-to-digital converter (ADC).

According to an embodiment, the second wireless communication module **502** may include a plurality of wireless communication circuits to process signals of different frequency bands. For example, the second wireless communication module **502** may include a plurality of wireless communication circuits to support a plurality of different wireless connection technologies. For example, the different wireless connection technologies may include Bluetooth low energy (BLE), Wi-Fi, Wi-Fi Gigabyte (WiGig) or a cellular network (e.g., LTE (long term evolution)). Further, the different frequency bands may include a super high frequency (SHF) (e.g., about 2.5 GHz or about 5 GHz) band or a millimeter wave (e.g., about 60 GHz) band.

According to an embodiment, the second wireless communication module **502** may include a baseband processor, at least one communication circuit (e.g., an intermediate frequency integrated circuit (IFIC)), or an RFIC. The second wireless communication module **502**, for example, may include a baseband processor that is separate from the processor **504** (e.g., an application processor (AP)).

According to an embodiment, the first wireless communication module **501** may include a first wireless communication circuit **730**. The second wireless communication module **502** may include at least one of a second wireless communication circuit **5022** or a third wireless communication circuit **5032**. The electronic device **500** may further include one or more interfaces for supporting communication between chips, between the second wireless communication module **502** and the processor **504**. The processor **504**, the first wireless communication circuit **730**, the second wireless communication circuit **5022**, or the third wireless communication circuit **5023** may transmit or receive data (or a signal) by using an interface (e.g., an inter processor communication channel) between chips.

According to an embodiment, the second wireless communication circuit **5022** or the third wireless communication circuit **5023** may provide an interface for performing communication with other objects. The second wireless communication circuit **5022**, for example, may support wireless communication for a second network (e.g., the second cellular network **294** of FIG. **2**) that utilizes an antenna module **610**. The third wireless communication circuit **5023**, for example, may support wireless communication for a first network (e.g., the first cellular network **292** of FIG. **2**) that utilizes at least one antenna **507**. According to an embodiment, the first network may include a 4th generation (4G) network, and the second network may include a 5th generation (5G) network. The 4G network, for example, may support a long term evolution (LTE) protocol ruled by 3GPP. The 5G network, for example, may support a new radio (NR) protocol ruled by 3GPP. According to various embodiments, the first network may be related to Wi-Fi or a global positioning system (GPS).

According to an embodiment, the third wireless communication circuit **5023** may receive a signal (hereinafter, a radio frequency (RF) signal) of high frequency for the first network (e.g., the 4G network) through at least one antenna **507**, and may modulate (e.g., down-convert) the received RF signal to a signal (hereinafter, a baseband signal) of low frequency and transmit the modulated RF signal to the processor **504**. The third wireless communication circuit **5023** may receive a baseband signal for the first network from the processor **504**, and may modulate (e.g., up-convert) the received baseband signal to an RF signal and transmit the modulated baseband signal to the outside through at least one antenna **507**. According to an embodiment, the first wireless communication circuit **730** of the first wireless communication module **501** may include an RFIC. According to various embodiments, when the RF signal is modulated to a baseband signal or a baseband signal is modulated to an RF signal, an input by a local oscillator (LO) may be utilized.

According to an embodiment, the second wireless communication circuit **5022** may receive a baseband signal for the second network from the processor **504**. The second wireless communication circuit **5022** may up-convert a baseband signal to an IF signal by utilizing an input (hereinafter, an LO signal) by the LO, and transmit an IF signal to the antenna module **610**. The antenna module **610** may receive an IF signal from the second wireless communication circuit **5022**. The antenna module **610** may up-convert an IF signal to an RF signal by utilizing an LO signal, and may transmit the RF signal to the outside through one or more antenna arrays **710** and **720** included in the antenna module **610**.

According to an embodiment, the antenna module **610** may receive an RF signal through one or more antenna arrays **710** and **720**. The antenna module **610** may down-convert an RF signal to an IF signal by utilizing an LO signal, and may transmit the IF signal to the second wireless communication circuit **5022**. The second wireless communication circuit **5022** may receive an IF signal from the antenna module **610**. The second wireless communication circuit **5022** may down-convert an IF signal to a baseband signal by utilizing an LO signal, and may transmit a baseband signal to the processor **504**. According to an embodiment, the second wireless communication circuit **5022** may include an IFIC. The second wireless communication circuit **5022** may transmit and/or receive a second signal of a frequency band of about 5 GHz to about 15 GHz.

According to an embodiment, the second wireless communication circuit **5022** or the first wireless communication circuit **730** may include a plurality of transmission/reception paths. For example, the second wireless communication circuit **5022** or the first wireless communication circuit **730** may include a beam forming system that processes a transmitted or received signal such that energy radiated from the plurality of antenna elements of the first antenna array **710** or the second antenna array **720** are concentrated on a specific direction in a space. The beam forming system may allow a strong signal to be received in a desired direction or delivered in a desired direction, or may prevent a signal coming from an undesired direction from being received. The beam forming system may adjust the form and the direction of beam by using a difference between the amplitudes or phases of carrier signals in an RF band. According to an embodiment, the second wireless communication circuit **5022** or the first wireless communication circuit **730** may be controlled to have a phase difference for the antenna elements. For example, the second wireless communication circuit **5022** or the first wireless communication circuit **730** may include a first electrical path electrically connected to a first point on the first antenna element and a second electrical path electrically connected to a second point on the second antenna element. The processor **504**, the second wireless communication circuit **5022**, or the first wireless communication circuit **730** may provide a phase difference between a first signal at the first point and a second signal at the second point. According to various embodiments (not illustrated), the electronic device **500** may include one or more phase shifters disposed in the antenna module **610** (or the first wireless communication circuit **730**) or the first printed circuit board **540**. The one or more phase shifters may adjust the phases for the plurality of antenna elements of the first array **710** or the second antenna array **720**.

For example, the beam forming system may form a beam pattern (e.g., the width and the direction of a beam) by adjusting the phases of current supplied to the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710** and the plurality of antenna elements **721**, **722**, **723**, and **724** of the second antenna array **720**. According to an embodiment, by the beam forming system, the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710** may form a beam that radiates a relatively large amount of energy in the first direction (e.g., a +z axis direction), which the first surface **611***a* of the first printed circuit board **611** faces. According to an embodiment, by the beam forming system, the plurality of antenna elements **721**, **722**, **723**, and **724** of the second antenna array **720** may form a beam that radiates a relatively large amount of energy in the second direction (e.g., a +y axis direction), which is perpendicular to the first direction and faces the third side surface part **513**.

According to an embodiment, the memory **505** may store codebook information on beam forming. The processor **504**, the first wireless communication circuit **730**, or the second wireless communication circuit **5022** may efficiently control (e.g., allocate or dispose) a plurality of beams through the plurality of antenna elements of the first antenna array **710** or the second antenna array **720**, based on the codebook information.

According to various embodiments, the second wireless communication module **502** including the second wireless communication circuit **5022** and/or the third wireless communication circuit **5023** may form one module together with the processor **504**. For example, the second wireless communication module **502** may be integrally formed with the processor **504**. In some embodiments, the second wireless communication circuit **5022** and/or the third wireless communication circuit **5023** may be disposed in one chip or may be formed in the form of independent chips.

According to an embodiment, the processor **504** and one wireless communication circuit (e.g., the second wireless communication circuit **5022**) may be integrally formed in one chip (SoC chip), and another wireless communication circuit (e.g., the third wireless communication circuit **5023**) may be formed in the form of an independent chip.

According to an embodiment, the power management module **506** may manage electric power supplied to the electronic device **500** by using a battery (e.g., the battery **189** of FIG. **1**) electrically connected to the second printed circuit board **540**.

Referring to FIG. **7**B, in an embodiment, the power management circuit **740** may be disposed on or coupled to the second surface **611***b* of the first printed circuit board **611** through a conductive bonding member such as solder, and may be electrically connected to the first printed circuit board **611**. The power management circuit **740** may be electrically connected to various other elements (e.g., a passive element) (not illustrated) disposed in the first wireless communication circuit **730**, the first connector **750**, or the first printed circuit board **611** through at least one wiring line included in the first printed circuit board **611**. The power management circuit **740** may receive electric power from the power management module **506** of FIG. **5**A through an electrical path such as an FPCB or a coaxial cable, and may manage electric power supplied to the antenna module **610** by using the received electric power. According to an embodiment, the power management circuit **740**, for example, may be implemented as at least a part of a power management integrated circuit (PMIC).

According to some embodiments, the power management circuit **740** may be omitted from the antenna module **610**. For example, the power management module **506** may manage the electric power supplied to the antenna module **610**.

According to an embodiment, the rear plate **580** may be formed of an insulator such as glass or a polymer or a dielectric material. According to an embodiment, the conductive layer **620***a* may be disposed between the rear plate **580** and the second printed circuit board **540**. According to an embodiment, the conductive layer **620***a* may be disposed in or coupled to the rear plate **580**. For example, the conductive layer **620***a* may be formed by coating a conductive material on the rear plate **580** or by attaching a conductive film (e.g., a copper film) or a conductive plate (e.g., a copper plate) to the rear plate **580**.

According to an embodiment, when viewed from the top of the rear plate **580**, the conductive layer **620***a* may not overlap the antenna module **610**. According to various embodiments, the rear plate **580** may not overlap one or more antenna arrays **710** and **720**.

Referring to FIG. **5**B, a film **620***b* may be disposed between the rear plate **580** and the second printed circuit board **540**. The film **620***b* may include a specific pattern or color, and may be viewed from the outside through the rear plate **580**. The film **620***b* may include a first area **621** formed of a nonconductive material and a second area **622** treated to have conductive characteristics in an area which does not overlap the antenna module **610**. The film **620***b* may be formed to include a conductive material through a method of coating a conductive material in the second area **622** or depositing a conductive material.

Referring to FIG. **6**, in an embodiment, when viewed from the top of the rear plate **580**, the antenna module **610** may be disposed at least partially between the third side surface part **513** and the conductive layer **620** (or the conductive area).

Hereinafter, unless described otherwise, the conductive layer **620** may be understood as a concept including an area (e.g., the second area **622** of FIG. **5**B) which, among the conductive layer **620***a* and the film **620***b* of FIG. **5**B, includes a conductive material.

Referring to FIG. **6**, in an embodiment, the electronic device **500** may include an antenna **570** (e.g., the at least one antenna **507**) disposed between the rear plate **580** and the battery (e.g., the battery **450** of FIG. **4**). According to an embodiment, the antenna **570** may be disposed in the rear plate **580**. The antenna **570** (e.g., the antenna **470** of FIG. **4**), for example, may include an NFC antenna, a wireless charging antenna, and/or an MST antenna. The antenna **570**, for example, may perform near field communication with an external device, or may wirelessly transmit and receive electric power that is necessary for charging. According to an embodiment, when viewed from the top of the rear plate **580**, the conductive layer **620** may be disposed between the antenna module **610** and the antenna **570**.

In an embodiment, the antenna **570** may include a coil as an antenna radiator. In an embodiment, the antenna **570** may include a plurality of coils. For example, each of the coils may be configured to support one of NFC, wireless charging, or MST. In an embodiment, the antenna **570** may include a printed circuit board in which coils are disposed.

In the disclosure, unless described otherwise, the antenna **570** may be understood as a concept including an antenna radiator, a communication circuit that feeds electric power to the antenna radiator, and/or a ground connected to the antenna radiator. For example, the antenna **570** may include a printed circuit board including a communication circuit, and an antenna radiator (e.g., a conductive pattern or a conductive patch) integrally formed with the printed circuit board.

In an embodiment, the antenna **570** may include a non-conductive member disposed at a location that is adjacent to the rear plate. For example, the antenna **570** may include a conductive protective film laminated on the antenna radiator, and the conductive protective film may be attached to the rear plate. In an embodiment, when the antenna **570** includes a printed circuit board, the antenna may include a nonconductive member disposed between the printed circuit board and the rear plate. In an embodiment, the nonconductive member may include a dielectric material, such as polyimide or plastic.

In an embodiment, a printed circuit board including electronic components and conductive patterns related to an operation of the antenna **570** may be provided. The printed circuit board of the antenna **570** may include a material having a permittivity that is different from that of the rear plate **580**. For example, when the rear plate **580** includes a material having a first permittivity, the printed circuit board of the antenna **570** may include a material having a second permittivity that is higher than the first permittivity.

Although not illustrated, in an embodiment of the disclosure, the antenna **570** disposed under the rear plate **580** may be replaced by another component. For example, the antenna **570** may be replaced by an electronic component, such as a camera module or a speaker module, which is disposed in an electronic device. As another example, the antenna **570** may be replaced by an antenna module that supports a millimeter wave that is different from that of the antenna module **610**. As another example, the antenna **570** may be replaced by an antenna radiator integrally formed with the rear plate **580**. In the embodiments, which will be described below, the antenna **570** may be understood as a concept that includes the components. For example, in FIGS. **5**A to **30**, the antenna **570** may be replaced by a speaker module.

In an embodiment, the antenna **570** (or a component that replaces the antenna **570**, hereinafter, the same) may include a dielectric member. A dielectric member may include a dielectric material having a permittivity that is different from that of the rear plate. For example, the rear plate **580** may include a dielectric material having a first permittivity, and the dielectric member may include a dielectric material having a second permittivity. Because the antenna **570** includes the dielectric member, the antenna may have a permittivity that is different from that of the rear plate **580**.

Referring to FIG. **5**A, according to an embodiment, the conductive layer **620***a* may reduce an electrical influence, by the rear plate **580**, on the antenna radiation characteristics (e.g., a beam pattern or a polarization state of electromagnetic waves) of the antenna module **610**. This is because the conductive layer **620** can shield electromagnetic waves (or electromagnetic fields). In an embodiment, the conductive layer **620***a* may include a material, such as aluminum (Al), copper (Cu), and silver (Ag), which can shield electromagnetic waves.

According to an embodiment, the conductive layer **620***a* can prevent electromagnetic waves radiated from the first antenna array **710** and/or the second antenna array **720** of the antenna module **610** from propagating through the rear plate **580** to be delivered to electrical elements such as the antenna **570**, and can reduce electrical influences, by the electromagnetic waves, on an electrical element such as the antenna **570**.

For example, when the conductive layer **620***a* is omitted, the rear plate **580** is a waveguide, through which electromagnetic waves radiated from the first antenna array **710** and/or the second antenna array **720** of the antenna module **610** propagate, and may be operated as a path for a medium that allows the electromagnetic waves to propagate by using a total reflection property. The antenna radiation characteristics of the antenna module **610**, for example, may include an antenna radiation pattern or a beam pattern that is a directional function which represents a relative distribution of electric power radiated from the antenna element **711**, **712**, **713**, **714**, **721**, **722**, **723**, or **724**, and a polarization state (or an antenna polarization) of electromagnetic waves radiated from the antenna element **711**, **712**, **713**, **714**, **721**, **722**, **723**, or **724**. When the rear plate **580** is operated as a waveguide, it may be difficult for the antenna module **610** to have antenna radiation characteristics corresponding to a selected or specified frequency, and accordingly, the antenna performance may deteriorate. When the electromagnetic waves radiated from the antenna module **610** is guided through the rear plate **580** and is delivered to the antenna **570**, the antenna performance may deteriorate.

According to an embodiment, the antenna module **610** may form a first beam pattern, in which the beam patterns formed in the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710** are combined with each other. The first beam pattern is an effective area in which the first antenna array **710** may radiate or detect electromagnetic waves, and may be formed by combining the radiated electric power of the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710**. According to an embodiment, the antenna module **610** may have a directivity by which electromagnetic wave energy may be concentrated or waves may be transmitted and received in a specific direction. For example, by the beam forming system, the first antenna array **710** may form a beam that radiates a relatively large amount of energy in the first direction (e.g., the +z axis direction), which the first surface **611***a* of the first printed circuit board **611** faces. For example, the first beam pattern may be in the form of a broadside. The first beam pattern in the form of a broadside may include a main lobe in a direction in which radiation energy becomes maximal substantially without side lobes. According to an embodiment, the first beam pattern may include a main lobe that is formed substantially in the first direction (e.g., the +z axis direction) that faces the first surface **611***a* of the first printed circuit board **611**. When the conductive layer **620** is omitted, at least some of the electromagnetic fields formed by the first antenna array **710** may be reflected on the rear plate **580**, and the reflected components may cause compensations and/or interferences in the maximal radiation direction (boresight) (e.g., the direction of the main lobe), causing deformation (distortion) of the first beam pattern. The deformation (distortion) of the first beam pattern, for example, may include a null formed between the lobes (e.g., radiation groups in which energy distributions of the electromagnetic waves are divided in various directions) of the first beam pattern. The null, for example, may indicate an ineffective area in which the first antenna array **710** cannot radiate or detect the electromagnetic waves. The null, for example, may indicate a direction in which the radiation intensity is substantially 0. According to an embodiment, the conductive layer **620** can prevent deformation (e.g., distortion) of the first beam pattern by reducing propagation of the electromagnetic waves (or waves) radiated from the first antenna array **710** through the rear plate **580** by total reflection.

When there is no conductive layer **620**, the electromagnetic waves generated in the antenna module **610** and propagating through the rear plate **580** may be total-reflected in the interior of the rear plate **580**. The electromagnetic waves radiated to the outside of the electronic device again as a part of the electromagnetic waves total-reflected in the interior of the rear plate **580** may lower the performance of the main beam (that is, a first beam) of the antenna module **610**.

According to an embodiment, the conductive layer **620** can prevent electromagnetic waves (or waves) radiated from the first antenna array **710** from propagating through the rear plate **580** to be delivered to electrical elements such as the antenna **570**, and can reduce electrical influences, by the electromagnetic waves, on an electrical element such as the antenna **570**. For example, the conductive layer **620** may shield or damp the electromagnetic waves (or waves) radiated from the first antenna array **710** between the antenna module **610** and the antenna **570**. According to an embodiment, the conductive layer **620** may reduce electrical influences on the frequency bands for the antenna **570** by the electromagnetic waves (or waves) radiated from the first antenna array **710**.

According to an embodiment, the electromagnetic waves radiated from the first antenna array **710** may include dually polarized waves. For example, the antenna module **610** may radiate horizontally polarized waves (H-pols) and vertically polarized waves (V-pols) through the first antenna array **710**. The polarizations may be in the direction of electric fields of the antenna. According to an embodiment, the horizontally polarized waves are linear polarizations in which the directions of the electric field vectors are horizontal, and may be parallel to the ground plane (e.g., a ground plane that is parallel to the x-y plane) included in the first printed circuit board **611**. According to an embodiment, the vertically polarized waves may be linear polarizations in which the directions of the electric field vectors are vertical, and may be perpendicular to the ground plane included in the first printed circuit board **611**. The ground plane may be related to the radiation characteristics of the antenna module **610**. For example, the radiation characteristics of the antenna module **610** may be determined based on a distance, by which the plurality of antenna elements included in the first antenna array **710** or the second antenna array **720** are spaced apart from the ground plane. For example, the radiation characteristics of the antenna module **610** may be determined based on the form (e.g., the width, the length, or the thickness) of the ground plane. For example, the radiation characteristics of the antenna module **610** may be determined based on an insulating material (e.g., the permittivity) between the plurality of antenna elements included in the first antenna array **710** or the second antenna array **720** and the ground plane.

According to an embodiment, the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710** may form horizontally polarized waves and vertically polarized waves through single feeding or multiple feeding. According to an embodiment, the location or the number of the feeding parts for the plurality of antenna elements **711**, **712**, **713**, and **714** of the first antenna array **710** may be variously set in consideration of impedance matching.

According to an embodiment, the film **620***b* including the conductive layer **620***a* or the conductive material is not limited to the form illustrated in FIG. **5**A or **5**B, and may be variously formed according to a boundary condition of the horizontally polarized waves for the rear plate **580** such that the deformation (or distortion) of the horizontally polarized waves radiated from the first antenna array **710** and the horizontally polarized waves can reduce an influence on an electrical element such as the antenna **570**.

According to an embodiment, the form of the conductive layer **620** may be related to the length of a wave that may shield noise (e.g., at least some of electromagnetic waves radiated from the antenna module **610**) for a frequency selected or specified by an antenna system that utilizes the antenna **570**. For example, when the selected or specified frequency is 2.4 GHz, the length of the conductive layer **620** in the y axis direction may be realized at a wavelength (about 30 mm) of 2.4 GHz or its threshold range. According to various embodiments, the antenna system may transmit or receive a frequency signal on Wi-Fi, 2G, 3G, LTE, 5G, or other various networks, and the conductive layer **620** may be formed to have a wavelength for the corresponding frequency.

In an embodiment, the conductive layer **620** may be located on waveguide paths (p) of, among the electromagnetic waves radiated from the antenna module **610**, the electromagnetic waves that face the y axis direction. In an embodiment, the conductive layer **620** may be configured to shield electromagnetic fields that face the y axis direction or substantially the y axis direction from the antenna module **610**. Accordingly, in an embodiment, the conductive layer **620** may have a width that is larger than that of the antenna module **610**. Referring to FIG. **6**, the antenna module **610** may have a first width w**1** in a second direction (that is, the +x axis direction) that is substantially perpendicular to the first direction (that is, the y axis direction) that faces the antenna **570** from the antenna module **610**. The width w**2** in the second direction of the conductive layer **620** may be larger than the first width w**1** of the antenna module **610**. Because the conductive layer **620** is configured to have a width that is larger than that of the antenna module **610**, the electromagnetic fields that propagate in the first direction from the antenna module **610** through the rear plate **580** can be shielded.

In an embodiment, a first distance d**1** between the conductive layer **620** and the antenna module **610** may be shorter than the second distance d**2** between the conductive layer **620** and the antenna **570**.

According to an embodiment, although not illustrated, the electronic device **500** may include an additional conductive layer between the antenna module **610** and the first side surface part **511**. For example, the conductive layer **620** may extend between the antenna module **610** and the first side surface part **511**. The conductive layer disposed between the antenna module **610** and the first side surface part **511** can prevent deformation (or distortion) of the vertically polarized waves, and can reduce an electrical influence on at least one electrical element between the first side surface part **511** and the antenna module **610** by the horizontally polarized waves.

According to an embodiment, the antenna module **610** may form a second beam pattern, in which the beam patterns formed in the plurality of antenna elements **721**, **722**, **723**, and **724** of the second antenna array **72**—are combined with each other. The second beam pattern is an effective area in which the second antenna array **720** may radiate or detect electromagnetic waves, and may be formed by combining the radiation power of the plurality of antenna elements **721**, **722**, **723**, and **724** of the second antenna array **720**. For example, the second beam pattern may be in the form of an end-fire. A main lobe and a side lobe that are radiation groups, in which energy distributions of electromagnetic waves radiated from the second antenna array **720** are divided in several directions, may be provided. For example, in the main lobe of the second beam pattern, the radiation energy may be formed substantially in the second direction (e.g., the +y axis direction) that faces the third side surface part **513**.

FIG. **8** is a perspective view of the electronic device of FIG. **5**A according to an embodiment of the disclosure.

FIG. **9** is a cross-sectional view of the electronic device of FIG. **8** according to an embodiment of the disclosure.

Referring to FIGS. **8** and **9**, in an embodiment, an electronic device **500** may include a front plate **520**, a side bezel structure **510**, a support member **515**, a display **530**, a second printed circuit board **540**, a battery **550**, an antenna **570**, a rear plate **580**, an antenna module **610** or a conductive layer **620**. At least one of the elements of the electronic device **500** may be the same as or similar to at least one of the elements illustrated in FIG. **5**A, and a repeated description thereof will be omitted below.

The front plate **520**, for example, may be the front plate **302** of FIG. **3**A or the front plate **420** of FIG. **4**. The support member **515**, for example, may be the first support member **411** of FIG. **4**. The support member **515** may be connected to the side bezel structure **510** or may be integrally formed with the side bezel structure **510**.

According to an embodiment, the support member **515** may include one surface **515***a*, on which the second printed circuit board **540** is disposed, and an opposite surface **515***b*, on which the display **530** (e.g., the display **430** of FIG. **4**) is disposed. The battery **550** may be electrically connected to the second printed circuit board **540** through an electrical path **594** such as an FPCB.

The electronic device **500** may include various electrical elements **591**, **592**, **593**, and **595** disposed in the second printed circuit board **540**. For example, the electrical elements **591**, **592**, and **593** may include an audio receiver **591**, a camera **592** (e.g., the second camera device **312** of FIG. **3**B), a communication circuit (e.g., the Wi-Fi integrated circuit (IC)) **593**, or a memory card connector (e.g., an SIM card connector) **595**. The second printed circuit board **540** may include a third surface **540***a* that faces the rear plate **580**, and a fourth surface **540***b* that faces the front plate **520**. The various electrical elements such as the audio receiver **591**, the camera **592**, or the communication circuit **593** may be disposed on the third surface **540***a*. The various elements such as the memory card connector **595** or the IC **596** may be disposed on the fourth surface **540***b*. The other various electrical elements (e.g., the elements included in the electronic device **101** of FIG. **1**) may be disposed on the third surface **540***a* or the fourth surface **540***b* of the first printed circuit board **540**.

According to an embodiment, the antenna module **610** may be disposed between the rear plate **580** and the second printed circuit board **540**. Although not illustrated, the antenna module **610** may be disposed in (or coupled to) a part that is connected to the support member **515** or extends from the support member **515**. The antenna module **610** may include a second printed circuit board **611** including the first antenna array **710** and/or the second antenna array **720**. The first printed circuit board **611** may include a first surface **611***a* that faces the rear plate **580**, and a second surface **611***b* that faces the second printed circuit board **540**. According to an embodiment, the first surface **611***a* (or the second surface **611***b*) of the first printed circuit board **611** may be substantially parallel to the third surface **540***a* or the fourth surface **540***b* of the second printed circuit board **540**.

In the illustrated embodiment, the antenna module **610** may be spaced apart from the rear plate **580** by a predetermined interval. For example, an air gap may be present between the antenna module **610** and the rear plate **580**. In another embodiment, the antenna module **610** may be adjacent to the rear plate **580**. For example, the antenna module **610** may be attached to the rear plate **580**.

The conductive layer **620**, for example, may be attached to the rear plate **580**. According to an embodiment, when viewed from the top of the rear plate **580**, the conductive layer **620** may be disposed in the rear plate **580** not to overlap the antenna module **610**. According to an embodiment, when viewed from the top of the rear plate **580**, the antenna module **610** may be disposed between the third side surface part **513** and the conductive layer **620**.

The antenna **570**, for example, may be attached to the rear plate **580**. According to another embodiment, the antenna **570** may be attached to the battery **550**. According to an embodiment, when viewed from the top of the rear plate **580**, the conductive layer **620** may be disposed between the antenna module **610** and the antenna **570**.

According to an embodiment, the conductive layer **620** can reduce propagation of the electromagnetic waves (e.g., the horizontally polarized waves or the vertically polarized waves) radiated from the first antenna array **710** or the second antenna array **720** through the rear plate **580** by total reflection to prevent deformation (e.g., distortion) of the electromagnetic waves. For example, when the conductive layer **620** is omitted, the electromagnetic waves can be reflected on the rear plate **580**, and the reflected components can cause deformation (or distortion) of the electromagnetic waves while causing compensations and/or interference.

According to an embodiment, the conductive layer **620** can prevent electromagnetic waves (or horizontally polarized waves or vertically polarized waves) radiated from the first antenna array **710** or the second antenna array **720** from propagating through the rear plate **580** to be delivered to electrical elements such as the antenna **570**, and can reduce electrical influences, by the electromagnetic waves, on an electrical element such as the antenna **570**. For example, the conductive layer **620** can shield or damp the electromagnetic waves between the antenna module **610** and the antenna **570**. According to an embodiment, the conductive layer **620** can reduce electrical influences, by the electromagnetic waves, on the frequency bands for the antenna **570**.

According to an embodiment, when viewed from the top of the rear plate **580**, the conductive layer **620** may be disposed at least to overlap the communication circuit (e.g., the Wi-Fi IC) **593**. The conductive layer **620** can reduce electrical influences, by the electromagnetic waves radiated from the first antenna array **710** or the second antenna array **720**, on the communication circuit **593**, and then can secure the performance of the communication circuit **593**.

FIG. **10** is a perspective view of the electronic device of FIG. **5**A according to an embodiment of the disclosure.

Referring to FIG. **10**, in an embodiment, an electronic device **1000** may include a front plate **520**, a side bezel structure **510**, a support member **515**, a display **530**, a second printed circuit board **540**, electrical elements **591**, **592**, **593**, and **595**, a battery **550**, an antenna **570**, a rear plate **580**, an antenna module **610** or a conductive layer **1020**. At least one of the elements of the electronic device **1000** may be the same as or similar to at least one of the elements illustrated in FIG. **9**, and a repeated description thereof will be omitted below.

According to an embodiment, the conductive layer **1020** may replace the conductive layer **620** of FIG. **9**. In an embodiment, the conductive layer **1020** may include a plurality of conductive patterns that are physically separated from each other. According to another embodiment (not illustrated), the conductive layer **1020** may be in the form including a plurality of openings. According to an embodiment, the conductive layer **1020** may be an electromagnetic band gap (EBG) structure for preventing an electromagnetic band gap (EBG) phenomenon. The EBG structure, for example, may be a structure that prevents at least some of the electromagnetic waves radiated from the antenna module **610** from being delivered to the antenna **570** as noise.

According to an embodiment, the plurality of conductive patterns included in the conductive layer **1020** may be arranged in the y axis direction at a predetermined interval. According to an embodiment, the interval between the plurality of patterns or the widths of the conductive patterns may be related to the length of a wave that may shield noise (e.g., at least some of electromagnetic waves radiated from the antenna module **610**) for a frequency selected or specified by an antenna system that utilizes the antenna **570**.

FIG. **11** illustrates a radiation pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure, and FIG. **12** illustrates a radiation pattern for a horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure.

FIG. **13** illustrates a radiation pattern for vertically polarized waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure, and FIG. **14** illustrates a radiation pattern for vertically polarized waves radiated from an antenna module, for example, when a conductive layer is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure.

Referring to FIG. **11**, in an embodiment, an electronic device **500** may include a front plate **520**, a side bezel structure **510**, a support member **515**, a display **530**, a second printed circuit board **540**, electrical elements **591**, **592**, **593**, **595**, and **596**, a battery **550**, an antenna **570**, a rear plate **580**, an antenna module **610** or a conductive layer **620**.

Referring to FIGS. **13** and **14**, when the conductive layer **620** is omitted, at least some of the electromagnetic waves (e.g., the horizontally polarized waves or the vertically polarized waves) radiated from the antenna module **610** may be reflected on the rear plate **580**, and the reflected components may cause deformation (or distortion) of the electromagnetic waves while causing compensations and/or interferences.

When the conductive layer **620** is omitted, at least some of the horizontally polarized waves radiated from the antenna module **610** may be guided in the −y axis direction **1201** through the rear plate **580** that is operated as a waveguide. The deformation (or distortion) of the horizontally polarized waves, for example, may include a null formed between the lobes of the horizontally polarized waves.

When there is no conductive layer **620**, the electromagnetic waves generated in the antenna module **610** and propagating through the rear plate **580** may be total-reflected in the interior of the rear plate **580**. The electromagnetic waves radiated to the outside of the electronic device again as a part of the electromagnetic waves total-reflected in the interior of the rear plate **580** may lower the performance of the main beam of the antenna module **610**. Referring to FIG. **13**, several circular electric waves may be formed along the rear plate **580** by the electromagnetic waves radiated to the outside of the electronic device again.

Referring to FIGS. **11** and **12**, the conductive layer **620** can reduce propagation of the electromagnetic waves radiated from the antenna module **610** through the rear plate **580** by total reflection to prevent deformation (e.g., distortion) of the electromagnetic waves For example, the conductive layer **620** can reduce propagation of the horizontally polarized waves radiated from the antenna module **610** to the −y axis direction **1201** through the rear plate **580**. According to an embodiment, the conductive layer **620** can prevent electromagnetic waves radiated from the antenna module **610** from propagating through the rear plate **580** to be delivered to electrical elements such as the antenna **570**, and can reduce electrical influences, by the electromagnetic waves, on an electrical element such as the antenna **570**.

FIG. **15** illustrates a beam pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure, and FIG. **16** illustrates a beam pattern for horizontally polarized waves radiated from an antenna module in the electronic device of FIG. **9** according to an embodiment of the disclosure.

FIG. **17** illustrates a beam pattern for horizontally polarized waves radiated from an antenna module, for example **1700**, when a conductive layer **620** is omitted from the electronic device of FIG. **9**, according to an embodiment of the disclosure, and FIG. **18** illustrates a beam pattern for horizontally polarized waves radiated from an antenna module, for example **1700**, when a conductive layer **620** is included in the electronic device of FIG. **9**, according to an embodiment of the disclosure.

Referring to FIGS. **15** and **16**, the antenna module **610** may form a beam pattern **1501** of the horizontally polarized waves, in which the beam patterns formed in the plurality of antenna elements of the first antenna array **710** of FIG. **5**A are combined with each other. The beam pattern **1501** of the horizontally polarized waves is an effective area in which the first antenna array **710** may radiate or detect electromagnetic waves, and may be formed by combining the radiated electric power of the plurality of antenna elements of the first antenna array **710**. According to an embodiment, by the beam forming system, the antenna module **610** may form a beam pattern **1501** of the horizontally polarized waves, in which a relatively large amount of energy is radiated in a direction (e.g., the −z axis direction) that faces the rear plate **580**. For example, the beam pattern **1501** of the horizontally polarized waves may be in the form of a broadside. The beam pattern of the horizontally polarized waves in the form of a broadside may include a main lobe in a direction in which radiation energy becomes maximal substantially without side lobes. According to an embodiment, the conductive layer **620** can prevent deformation (e.g., distortion) of the horizontally polarized waves by reducing propagation of the horizontally polarized waves radiated from the antenna module **610** through the rear plate **580** by total reflection.

Referring to FIGS. **17** and **18**, when the conductive layer **620** is omitted, at least some of the horizontally polarized waves radiated from the antenna module **610** may be reflected on the rear plate **580**, and the reflected components may cause deformation (or distortion) of the horizontally polarized waves while causing compensations and/or interferences. The deformation (or distortion) of the horizontally polarized waves, for example, may form nulls **1701**, **1702**, **1703**, **1704**, and **1705** that indicate an ineffective area, in which electromagnetic waves cannot be radiated or detected or a direction, in which radiation intensity is substantially 0.

FIG. **19** is a cross-sectional view of an electronic device including an antenna module according to an embodiment of the disclosure.

FIG. **20** is a perspective view, for example, of the electronic device of FIG. **19**, according to an embodiment of the disclosure.

Referring to FIGS. **19** and **20**, in an embodiment, an electronic device **1900** (e.g., the electronic device **101** of FIG. **1**, the electronic device **300** of FIG. **3**A or **3**B, or the electronic device **400** of FIG. **4**) may include at least one of a front plate **1910** (e.g., the front plate **420** of FIG. **4**), a rear plate **1920** (e.g., the rear plate **480** of FIG. **4**), a side bezel structure **1930** (e.g., the side bezel structure **410** of FIG. **4**), a support member **1940** (e.g., the first support member **411** of FIG. **4**), an antenna module **1950** (e.g., the antenna module **610** of FIG. **7**A or **7**B), a conductive layer **1980** (e.g., the conductive layer **620** of FIG. **9**), a second printed circuit board **1960** (e.g., the printed circuit board **440** of FIG. **4**), or a flexible printed circuit board **1970**. At least one of the elements of the electronic device **1900** may be the same as or similar to at least one of the elements illustrated in FIG. **4**, and a repeated description thereof will be omitted below.

For example, the front plate (or a window) may define a front surface of the electronic device **1900**, and the rear plate (or a rear cover) **1920** may define a rear surface of the electronic device **1900**. The side bezel structure **1930** may at least partially surround a space between the front plate **1910** and the rear plate **1920**, and may define a side surface **1930***a* of the electronic device **1900**.

According to an embodiment, the front plate **1910** may include a first planar portion **1911** and a first curved portion **1912**. The first curved portion **1912** may extend from the first planar portion **1911**, and may be curved toward the rear plate **1920**. The front surface of the electronic device **1900** may include a first planar surface **1910***a* defined by the first planar portion **1911**, and a first curved surface **1910***b* defined by the first curved portion **1912** and extending from an edge (not illustrated) of the first planar surface **1910***a*. According to various embodiments, the first planar surface **1910***a* may be the front surface **310**A of FIG. **3**A, and the first curved surface **1910***b* may be one of the two first areas **310**D of FIG. **3**A.

According to an embodiment, the rear plate **1920** may include a second planar portion **1921** and a second curved portion **1922**. The second curved portion **1922** may extend from the second planar portion **1921**, and may be curved toward the front plate **1910**. The rear surface of the electronic device **1900** may include a second planar surface **1920***a* defined by the second planar portion **1921**, and a second curved surface **1920***b* defined by the second curved portion **1922** and extending from an edge (not illustrated) of the second planar surface **1920***a*. According to various embodiments, the second planar surface **1920***a* may be the rear surface **310**B of FIG. **3**A, and the second curved surface **1920***b* may be one of the two second areas **310**E of FIG. **3**B.

The side surface **1930***a* (e.g., the side surface **310**C of FIG. **3**A) of the electronic device **1900** may connect the first curved surface **1910***b* of the front plate **1910** and the second curved surface **1920***b* of the rear plate **1920**. According to some embodiments (not illustrated), the first curved portion **1912** of the front plate **1910** and/or the second curved portion **1922** of the rear plate **1920** may be formed to be planar.

According to an embodiment, the support member **1940** (e.g., the bracket) may be disposed in the interior of the electronic device **1900** to be connected to the side bezel structure **1930** or to be integrally formed with the side bezel structure **1930**. The support member **1940**, for example, may be formed of a metallic material and/or a nonmetallic material (e.g., a polymer). The support member **1940** may include one surface **1940***a*, on which the display (not illustrated) (e.g., the display **430** of FIG. **4**) is disposed, and an opposite surface **1940***b*, on which the second printed circuit board **1960** is disposed. The display may be disposed at least partially along the front plate **1911**. For example, the display may be a flexible display, and may include a planar area disposed along the first planar portion **1911** and a curved area disposed along the first curved portion **1912**.

According to an embodiment, the second printed circuit board **1960** may include a fourth surface **1960***b* that faces the support member **1940** and a third surface **1960***a* that faces a direction that is opposite to the direction the fourth surface **1960***b* faces. According to an embodiment, the antenna module **1950** (e.g., the third antenna module **246** of FIG. **2** or the antenna module **610** of FIG. **7**A) may include a first printed circuit board **1951** (e.g., the first printed circuit board **611** of FIG. **7**A). The first printed circuit board **1951** may include a first surface **1951***a*, and a second surface **1951***b* that faces a direction that is opposite to the first surface **1951***a*. According to an embodiment, the second printed circuit board **1960** may be disposed to be substantially perpendicular to the first printed circuit board **1951**. For example, the third surface **1960***a* (or the fourth surface **1960***b*) of the second printed circuit board **1960** may define an angle of substantially 90° with the first surface **1951***a* or the second surface **1951***b* of the first printed circuit board **1951**. According to an embodiment, the support member **1940** may include a portion **1941** extending between the second printed circuit board **1960** and the first printed circuit board **1951**, and the first printed circuit board **1951** may be disposed at the portion **1941**.

According to an embodiment, the first printed circuit board **1951** may be perpendicular to a first planar portion **1911** of the front plate **1910** and/or a second planar portion **1921** of the rear plate **1920**. According to an embodiment, the second curved portion **1922** of the rear plate **1920** may extend from the second planar portion **1921** to be curved to the front side of the first surface **1951***a* of the first printed circuit board **1951**.

According to an embodiment, the first printed circuit board **1951** may be disposed to define an acute angle or an obtuse angle with the second printed circuit board **1960**. For example, the third surface **1960***a* (or the fourth surface **1960***b*) of the second printed circuit board **1960** may define an acute angle or an obtuse angle with the first surface **1951***a* or the second surface **1951***b* of the first printed circuit board **1951**.

Referring to FIGS. **19** and **20**, the electronic device **1900** may include a third connector **2091** disposed at one end of the flexible printed circuit board **1970**, and a fourth connector **2092** disposed at an opposite end of the flexible printed circuit board **1970**. The third connector **2091** may be electrically connected to the first connector (e.g., the first connector **750** of FIG. **7**B) disposed in the first printed circuit board **1951**, and the fourth connector **2092** may be electrically connected to the second connector (not illustrated) disposed in the second printed circuit board **1960**.

The antenna module **1950**, for example, may include at least a portion of the antenna module **610** illustrated in FIG. **7**A or **7**B. According to an embodiment, the antenna module **1950** may include a first antenna array **1952** (e.g., the first antenna array **710** of FIG. **7**A) and/or a second antenna array **1953** (e.g., the second antenna array **720** of FIG. **7**A). According to an embodiment, the antenna module **1950** may include a first wireless communication circuit (e.g., the first wireless communication circuit **730** of FIG. **7**B) mounted on the second surface **1951***b*.

According to an embodiment, the first antenna array **1952** and/or the second antenna array **1953** may be disposed closer to the first surface **1951***a* than to the second surface **1951***b* or may be disposed on the first surface **1951***a*. According to an embodiment, the plurality of antenna elements included in the first antenna array **1952** may include a patch antenna, and the plurality of antenna elements included in the second antenna array **1953** may include a dipole antenna. According to an embodiment, the locations or the number of the antenna arrays or the antenna elements included in the antenna arrays are not limited to the example illustrated in FIG. **20**, and may be variously set.

According to an embodiment, the first antenna array **1952** may be disposed to be closer to the rear plate **1920** than the second antenna array **1953**. The second antenna array **1953** may be disposed to be closer to the front plate **1910** than the first antenna array **1952**.

According to an embodiment, the beam forming system may form the direction of a beam by adjusting the phase of a current supplied to the plurality of antenna elements of the first antenna array **1952** or the plurality of antenna elements of the second antenna array **1953**. For example, referring to FIG. **19**, by the beam forming system, the antenna module **1950** may form a beam, from which a relatively large amount of energy is radiated, in a first direction **1901** (e.g., the +x axis direction) which the first surface **1951***a* of the first printed circuit board **1951** faces, and/or in a second direction **1902** (e.g., the −z axis direction) which is perpendicular to the first direction **1901** to face the rear plate **1920**. As another example, by the beam forming system, the antenna module **1950** may form a beam, from which a relatively large amount of energy is radiated, in a third direction **1903** between the first direction **1901** and the second direction **1902**. For example, the third direction **1903** may define an angle of about 45° with the first direction **1901** or the second direction **1902**. According to an embodiment, by the beam forming system, the antenna module **1950** may form a beam, from which a relatively large amount of energy is radiated, in other various directions.

According to an embodiment, the rear plate **1920** may be formed of an insulator such as glass or a polymer or a dielectric material. According to an embodiment, the conductive layer **1980** may be disposed between the rear plate **1920** and the second printed circuit board **1960**. According to an embodiment, the conductive layer **1980** may be disposed in or coupled to the rear plate **1920**. For example, the conductive layer **1980** may be formed by coating a conductive material on the rear plate **1920** or attaching a conductive film or a conductive plate.

According to an embodiment, when viewed from the top of the rear plate **1920**, the conductive layer **1980** may at least partially overlap the second printed circuit board **1960**. According to an embodiment, when viewed from the top of the rear plate **1920**, the conductive layer **1980** may be disposed not to overlap the first printed circuit board **1951**.

According to an embodiment, the conductive layer **1980** may be disposed at the second planar portion of the rear plate **1920**. According to some embodiments (not illustrated), the conductive layer **1980** may be expanded to the second curved portion **1922** of the rear plate **1920** in a range that does not cover the first surface **1951***a* of the antenna module **1950**.

According to an embodiment, the antenna module **1950** may have a directivity by which electromagnetic wave energy may be concentrated or waves may be transmitted and received in a specific direction. According to an embodiment, the antenna module **1950** may form a beam pattern in which beam patterns formed in the plurality of antenna elements of the first antenna array **1952** or the second antenna array **1953** are combined with each other. The beam pattern is an effective area in which the first antenna array **1952** or the second antenna array **1953** may radiate or detect electromagnetic waves, and may be formed by combining radiated electric power of the plurality of antenna elements of the first antenna array **1952** or the second antenna array **1953**. According to an embodiment, the antenna module **1950** may form a beam, from which a relatively large amount of energy is radiated, in at least one of the first direction **1901** (e.g., the +x axis direction) and the second direction **1902** (e.g., the −z axis direction) through the first antenna array **1952** or the second antenna array **1953**. According to an embodiment, the antenna module **1950** may form a beam, from which a relatively large amount of energy is radiated, in at least one of the first direction **1901** and the third direction **1903** through the first antenna array **1952** or the second antenna array **1953**. According to an embodiment, the antenna module **1950** may form a beam, from which a relatively large amount of energy is radiated, in at least one of the second direction **1902** and the third direction **1903** through the first antenna array **1952** or the second antenna array **1953**. According to an embodiment, the electromagnetic waves radiated from the first antenna array **1952** or the second antenna array **1953** may include horizontally polarized waves and vertically polarized waves. According to an embodiment, the horizontally polarized waves are linear polarizations in which the directions of the electric field vectors are horizontal, and may be parallel to the ground plane (e.g., a ground plane that is parallel to the x-y plane) included in the first printed circuit board **1951**. According to an embodiment, the vertically polarized waves may be linear polarizations in which the vector directions of the electric fields are vertical, and may be perpendicular to the ground plane included in the first printed circuit board **1951**. For example, the electromagnetic waves (e.g., the horizontally polarized waves or the vertically polarized waves) radiated from the first antenna array **1952** or the second antenna array **1953** may face the rear plate **1920** by directivity, and the electromagnetic waves may be reflected on the rear plate **1920** and the reflected components may cause compensations and/or interferences in a maximum radiation direction (boresight), causing deformation (or distortion) of the electromagnetic waves. According to an embodiment, the conductive layer **1980** may reduce deformation (or distortion) of the electromagnetic waves by changing a border condition of the electromagnetic waves for the rear plate **1920**.

For example, when the conductive layer **1980** is omitted, the rear plate **1920** is a waveguide, through which electromagnetic waves radiated from the first antenna array **1952** and/or the second antenna array **1953** of the antenna module **1950** propagate, and for example, may be operated as a path for a medium that allows the electromagnetic waves to propagate by using a total reflection property. When the rear plate **1920** is operated as a waveguide, it may be difficult for the antenna module **1950** to secure antenna radiation characteristics corresponding to a selected or specified frequency, and accordingly, the antenna performance of the antenna module **1950** may deteriorate. When the electromagnetic waves radiated from the antenna module **1950** propagate through the rear plate **1920**, accordingly, the performance of the electrical element, such as the antenna **570** of FIG. **8** or **9** can deteriorate.

According to an embodiment, the conductive layer **1980** can prevent deformation (e.g., distortion) of the antenna radiation characteristics by reducing propagation of the electromagnetic waves radiated from the antenna module **1950** through the rear plate **1920**.

According to an embodiment, the conductive layer **1980** can secure the performance of an electrical element, such as the antenna **570** of FIG. **8** or **9** by reducing propagation of the electromagnetic waves radiated from the antenna module **1950** through the rear plate **1920**. For example, the conductive layer **1980** may shield or damp the electromagnetic waves (or waves) radiated from the first antenna array **1952** or the second antenna array **1953** between the electrical elements such as the antenna module **1950** and the antenna **570**.

According to an embodiment, the conductive layer **1980** is not limited to the form illustrated in FIG. **19**, and may be variously formed according to a border condition of the electromagnetic waves for the rear plate **1920** such that deformation (or distortion) of the electromagnetic waves (e.g., the horizontally polarized waves or the vertically polarized waves) radiated from the antenna module **1950** and an influence, by the electromagnetic waves, on other electrical elements (e.g., the antenna **570** of FIG. **8** or **9**). According to an embodiment (not illustrated), the conductive layer **1980** may be realized by a plurality of conductive patterns physically separated as in the conductive layer **1020** of FIG. **10**. According to an embodiment (not illustrated), the conductive layer **1980** may be realized in the form including a plurality of openings. For example, the conductive layer **1980** may be formed in an EBG structure.

FIG. **21** illustrates a beam pattern for electromagnetic waves radiated from an antenna module in the electronic device of FIG. **19** or **20** according to an embodiment of the disclosure.

FIG. **22** illustrates a beam pattern for electromagnetic waves radiated from an antenna module, for example, in an example **2200** in which a conductive layer **1980** is omitted from the electronic device of FIG. **19** or **20**, according to an embodiment of the disclosure.

FIG. **23** is a graph depicting an antenna gain in a frequency distribution in the electronic device of FIG. **19** or **20** according to an embodiment and in the embodiment of FIG. **22**.

Referring to FIG. **22**, the electromagnetic waves (e.g., the vertically polarized waves) radiated from the antenna module **1950** may have a beam that faces the rear plate **1920** by directivity. The beam is reflected on the rear plate **1920**, and the reflected components may cause compensations and/or interferences in a maximum radiation direction (boresight), causing deformation (or distortion) of the beam pattern as in FIG. **22**. Referring to FIG. **21**, in an embodiment, the conductive layer **1980** may reduce deformation of the electromagnetic waves by changing a border condition of the electromagnetic waves for the rear plate **1920**. Referring to FIG. **21**, in an embodiment, the conductive layer **1980** can reduce deformation of a beam pattern and secure an antenna gain by shielding or damping at least some of the electromagnetic waves guided to the rear plate **1920**.

Referring to FIG. **23**, reference numeral **2301** denotes an antenna gain on a frequency distribution for the electronic device of FIG. **19** or **20**, and reference numeral **2303** denotes an antenna gain on a frequency distribution for the embodiment of FIG. **22**. In comparison of **2301** and **2303**, the conductive layer **1980** of FIG. **19** according to an embodiment can increase a peak gain.

FIG. **24** is a cross-section of an electronic device, taken along line I-I of FIG. **6**, according to an embodiment of the disclosure.

FIG. **25** is a cross-section of an electronic device, taken along line I-I of FIG. **6**, according to an embodiment of the disclosure, and FIG. **26** is a cross-section of an electronic device, taken along line I-I of FIG. **6**, according to an embodiment of the disclosure.

Referring to FIGS. **24** to **26**, in an embodiment, the antenna module **610** may be disposed at a location corresponding to the first portion **581** of the rear plate **580**. The electromagnetic waves of the antenna module **610** may pass through the first portion **581** of the rear plate **580** and may be radiated to the outside of the electronic device. Accordingly, a member (e.g., a conductive member or a ferrite film) that may shield electromagnetic waves may not be disposed between the first portion **581** of the rear plate **580** and the antenna module **610**.

Referring to FIGS. **24** and **25**, the antenna **570** (or a component that replaces the antenna **570**, see the description of FIG. **6**) may be disposed under the rear plate **580**. The antenna **570** may be located to be spaced apart from the antenna module **610** in a direction (e.g., the −y axis direction) that is parallel to the rear plate **580**. For example, the antenna **570** may be disposed under the third portion **583** of the rear plate **580**.

Referring to FIGS. **24** and **25**, in an embodiment, when the x-y plane is viewed, the conductive layer **620*a*** may not overlap the antenna module **610**. For example, the conductive layer **620*a*** may be disposed under the second portion **582** of the rear plate **580**, which is adjacent to the first portion **581** of the rear plate **580**. The conductive layer **620*a*** can shield electromagnetic fields that are generated in the antenna module **610** and propagate to the second portion **582** of the rear plate **580** along the rear plate **580**.

Referring to FIGS. **24** and **25**, in an embodiment, the conductive layer **620*a*** may be disposed between the antenna module **610** and the antenna **570**. In an embodiment, the conductive layer **620*a*** may extend toward the antenna **570** at a portion that is adjacent to the antenna module **610**. For example, the antenna **570** may be disposed under the third portion **583** of the rear plate **580**, which is adjacent to the second portion **582**. In an embodiment, the conductive layer **620*a*** may be disposed to be closer to the antenna module **610** than to the antenna **570**. For example, an interval d**1** between the conductive layer **620*a*** and the antenna module **610** may be smaller than an interval d**2** between the conductive layer **620*a*** and the antenna **570**.

In an embodiment, the rear plate **580** may include a first surface that faces the outside of the electronic device, and a second surface that faces the interior of the electronic device. In an embodiment, the antenna module **610** may be disposed at a location of the second surface of the rear plate **580**, which is adjacent to the first area corresponding to the first portion **581**, and a conductive member may be disposed at a location of the second surface of the rear plate **580**, which is adjacent to the second area corresponding to the second portion **582**. For example, the antenna module **610** and the conductive layer **620*a*** may be attached onto the first area and the second area, respectively. The conductive layer **620*a*** can shield electromagnetic fields that are generated in the antenna module **610** and propagate to the second portion **582** of the rear plate **580** along the rear plate **580**.

In an embodiment, a component including a dielectric material may be disposed at a location of the second surface, which is adjacent to the third area corresponding to the third portion **583**. For example, the antenna **570** may be attached to the third area of the rear plate **580**.

Referring to FIGS. **24** and **25**, in an embodiment, the electronic device may include a film **620*b*** disposed between the conductive layer **620*a*** and the rear plate **580**. The film **620*b*** is a layer deposited or coating under the rear plate **580**, and may be viewed from the outside of the electronic device through the rear plate **580**. In an embodiment, the conductive layer **620*a*** may be realized by directly depositing (or coating) a conductive material on one surface of the film **620*b*** or attaching a conductive member to the film **620*b***. In the embodiment illustrated in FIG. **25**, the conductive layer **620*a*** may be attached under the film **620*b*** through a bonding member **630**.

Although not illustrated, in an embodiment, the conductive layer **620*a*** may be disposed directly under the rear plate **580**. For example, the conductive layer **620*a*** may be realized by attaching a film including a conductive material to one surface of the rear plate **580**. A bonding member may be attached between the conductive layer **620*a*** and the rear plate **580**. As another example, the conductive layer **620*a*** may be realized by depositing (or coating) a conductive material on the rear plate **580**.

Although not illustrated, in an embodiment, the conductive layer **620*a*** may be electrically connected to a ground in the interior of the electronic device. In an embodiment, the conductive layer **620*a*** may be grounded to a component including the ground in the electronic device. For example, the electronic device may include a bracket configured to support the display therein and including a conductive material, and the conductive layer **620*a*** may be electrically connected to the bracket. As another example, the electronic device may include a printed circuit board (e.g., the second printed circuit board **540** of FIG. **5**A) including a ground therein, and the conductive layer **620*a*** may be electrically connected to the ground of the printed circuit board.

Referring to FIG. **26**, the film **620*b*** may include a first area **621** formed of a nonconductive material and a second area **622** treated to have conductive characteristics in an area which does not overlap the antenna module **610**. The second area **622** may be located under the second portion **582** of the rear plate **580**. In this case, the second area **622** of the film **620*b*** may replace the conductive layer **620*a*** of FIGS. **24** and **25**. This is because the film **620*b*** can shield electromagnetic fields that propagate from the antenna module **610** in the −y axis direction when the film **620*b*** includes a conductive material.

FIG. **27** illustrates an electronic device including an antenna module seated in a mid-frame according to an embodiment of the disclosure.

FIG. **28** is a cross-sectional view of the electronic device of FIG. **27**, taken along line II-II, according to an embodiment of the disclosure.

In an embodiment, the antenna module **610** may be disposed on a mid-frame **640** disposed between the second printed circuit board **540** and the rear plate **580**. In an embodiment, the antenna module **610** may be electrically connected to the second printed circuit board **540** through a conductive path that passes through or detour the mid-frame **640**.

In an embodiment, the antenna module **610** may be seated on a recessed portion (or a recess) **641** formed in the mid-frame **640**. In an embodiment, the recessed portion **641** may be disposed such that an air gap **642** is present between the antenna module **610** and the rear plate **580** when the antenna module **610** is seated in the recessed portion **641**.

In an embodiment, the mid-frame **640** may include a nonconductive member **643** and a conductive member (or a conductive pattern or a shield member) **644**. In an embodiment, the conductive member **644** may include a radiator of an antenna that is different from the antenna module **610**. For example, a radiator of a Wi-Fi antenna and/or a GPS antenna may be disposed on the mid-frame **640**. In an embodiment, the nonconductive member **643** and the conductive member **644** may be integrally formed with each other through dual injection-molding or insert injection-molding.

In an embodiment, the conductive member **644** of the mid-frame **640** may be disposed around the recessed portion **641**. For example, the conductive member **644** may be disposed at a location that is adjacent to the recessed portion **641**. In an embodiment, the conductive member **644** may at least partially surround a border of the recessed portion **641**. In an embodiment, two or more conductive members that are separated from each other may at least partially surround a border of the recessed portion **641**.

In an embodiment, when the antenna module **610** is seated in the recessed portion **641**, the conductive member **644** may be adjacent to the border of the antenna module **610**. The conductive member **644** may be disposed along at least a portion of the border of the antenna module **610**. Accordingly, at least a portion of the antenna module **610** may be surrounded by the conductive member **644**. In an embodiment, the conductive member **644** may be disposed to surround a −y axis direction border **631** of the antenna module **610**. In this case, the electromagnetic fields that propagate from the antenna module **610** in the −y axis direction can be shielded by the conductive member **644**.

According to an embodiment, the conductive member **644** of the mid-frame **640** may reduce an electrical influence, by the rear plate **580**, on the antenna radiation characteristics (e.g., a beam pattern or a polarization state of electromagnetic waves) of the antenna module **610**. This is because the conductive member **644** prevents propagation of the electromagnetic fields radiated from the antenna module **610** through the rear plate **580**.

FIG. **29** illustrates an electronic device including a conductive layer of a mid-frame and a conductive layer attached to a rear frame according to an embodiment the disclosure.

FIG. **30** is a cross-sectional view of the electronic device of FIG. **29**, taken along line III-III, according to an embodiment of the disclosure.

Referring to FIG. **30**, the arrangement of the antenna module **610** at the recessed portion **841** of the mid-frame **840** is the same as in the embodiment illustrated in FIG. **27**. However, referring to FIG. **29**, differently from in the embodiment of FIG. **27**, in an embodiment, the conductive member **844** may be opened in the −y axis direction. For example, the conductive member **844** of the mid-frame **840** may surround only a portion of the −y direction border **631** of the antenna module **610**. The form and the location of the conductive member **844** illustrated in FIG. **29** correspond to a simple example. For example, the length, by which the conductive member **844** extends along the border of the antenna module **610**, may be different from that illustrated in FIG. **29**.

Some of the electromagnetic fields generated in the antenna module **610** may pass through a portion **845**, which is not surrounded by the conductive member **844**, and may be guided in the −y axis direction. The electromagnetic fields that were guided in the −y axis direction may propagate through the rear plate **580**, which may cause deterioration of the performance of the antenna module **610**. In an embodiment, the electromagnetic fields that are guided from the antenna module **610** in the −y axis direction can be shielded by the conductive layer **620***a*, which will be described below.

In an embodiment, the electronic device may include a conductive layer **620***a* disposed under the rear plate **580**. The conductive layer **620***a* of FIG. **29** is substantially the same as the conductive layer **620***a* illustrated in FIGS. **6** to **11**, and a repeated description thereof will be omitted. For example, when the x-y plane is viewed, the conductive layer **620***a* may be attached under the second portion **582** of the rear plate **580** not to overlap the antenna module **610** disposed under the first portion **581** of the rear plate **580**.

In an embodiment, the conductive layer **620***a* may be located in an area of the border of the antenna module **610**, which corresponds to the portion **845** that is not surrounded by the conductive member **844**. For example, the conductive layer **620***a* may be disposed along a path of some of the electromagnetic fields generated in the antenna module **610**, which pass through the portion **845** that is not surrounded by the conductive member **844**. In an embodiment, the width of the conductive layer **620***a* may correspond to the length of the portion **845** of the −y axis border **631** of the antenna module **610**, which is not surrounded by the conductive member **844**. Accordingly, the electromagnetic fields that are guided from the antenna module **610** in the −y axis direction can be shielded by the conductive layer **620***a*.

In an embodiment, a portable communication device (e.g., the electronic device **500** of FIG. **5**A) may include a display (e.g., the display **530** of FIG. **8**) defining a front surface of the portable communication device, a plate (e.g., the rear plate **580** of FIG. **6**) defining a rear surface of the portable communication device and including a nonconductive material, the plate including a first surface facing the outside of the portable communication device and a second surface facing the inside of the portable communication device, a first antenna module (e.g., the antenna module **610** of FIG. **24**) attached to a first area (e.g., the first portion **581** of FIG. **24**) of the second surface or positioned to be adjacent to the first area, a second antenna module (e.g., the antenna **570** of FIG. **24**) attached to a second area (e.g., the third portion **583** of FIG. **24**) of the second surface or positioned to be adjacent to the second area, and a conductive member (e.g., the conductive layer **620***a* of FIG. **24**) disposed in or attached to a third area (e.g., the second portion **582** of FIG. **24**) between the first area and the second area of the second surface, and among electric waves radiated from the first antenna module, some electric waves that travel towards the second antenna module through the plate may be at least partially interrupted by the conductive member.

In an embodiment, the first antenna module may have a first width in a second direction (e.g., the x axis direction of FIG. **6**) that is substantially perpendicular to a first direction (e.g. the y axis direction of FIG. **6**) facing the second antenna module from the first antenna module and is substantially parallel to the rear surface, and the conductive member may have a second width (e.g., the second width w**2** of FIG. **6**) in the second direction, which is larger than the first width.

In an embodiment, the conductive member may be grounded through, except for the first antenna module and the second antenna module, another component in the portable communication device.

In an embodiment, the other component may include a bracket at least partially supporting the plate or the display, and the conductive member may be electrically connected to a ground of the bracket.

In an embodiment, the conductive member may be spaced apart from the first antenna module by a first distance (e.g., the first distance d**1** of FIG. **6**), and may be spaced apart from the second antenna module by a second distance (e.g., the second distance d**2** of FIG. **6**) that is larger than the first distance.

In an embodiment, the conductive member may be deposited in the third area.

In an embodiment, the portable communication device may further include a film (e.g., the film **620***b* of FIG. **25**) positioned between the third area and the conductive member, and a bonding layer positioned between the third area and the film.

In an embodiment, the plate may include glass.

In an embodiment, the first antenna module may include a first printed circuit board (e.g., the first printed circuit board **611** of FIG. **7**A) and a first antenna (e.g., the first array **710** of FIG. **7**A) positioned in the first printed circuit board, and the second antenna module may include a second printed circuit board and a second antenna positioned in the second printed circuit board.

In an embodiment, the second antenna may include a coil configured to support near field communication.

In an embodiment, the second antenna module may include a nonconductive member positioned between the plate and the second printed circuit board.

In an embodiment, a portable communication device may include a display defining a front surface of the portable communication device, a plate defining a rear surface of the portable communication device and including a nonconductive material, the plate including a first surface facing the outside of the portable communication device and a second surface facing the inside of the portable communication device, an antenna disposed in or attached to a first area of the second surface or positioned to be adjacent to the first area, a component disposed in or attached to a second area of the second surface, and a conductive member disposed in or attached to a third area between the first area and the second area of the second surface, and among electric waves radiated from the antenna, some electric waves that travel toward the component through the plate may be at least partially interrupted by the conductive member.

In an embodiment, the antenna may have a first width in a second direction that is substantially perpendicular to a first direction facing the component from the antenna and is substantially parallel to the rear surface, and the conductive member may have a second width in the second direction, which is larger than the first width.

In an embodiment, the conductive member may be spaced apart from the antenna by a first distance, and may be spaced apart from the component by a second distance that is larger than the first distance.

In an embodiment, the portable communication device may further include a film positioned between the third area and the conductive member, and a bonding layer positioned between the third area and the film.

In an embodiment, the portable communication device may further include a first printed circuit board, in which the antenna is positioned, and the component may include a second printed circuit board and a second antenna positioned in the second printed circuit board.

In an embodiment, the portable communication device may further include a shield member positioned adjacent to the antenna, and the shield member may include a conductive pattern, which is opened in a first direction facing the second antenna from the antenna and at least a portion of which is disposed in a second direction that is different from the first direction.

In an embodiment, a portable communication device may include a display defining a front surface of the portable communication device, a plate defining a rear surface of the portable communication device and including a dielectric material, an antenna module positioned below the plate to be spaced apart from the plate, wherein electric waves generated by the antenna module pass through the plate and are radiated to the outside of the portable communication device, a dielectric member positioned under the plate and having a permittivity that is different from the permittivity of the plate, the dielectric member being spaced apart from the antenna module in a direction that is parallel to the plate, and a conductive member positioned under the plate and extending from a portion, which is adjacent to the antenna module, toward the dielectric member.

In an embodiment, the antenna module may have a first width in a second direction that is substantially perpendicular to a first direction facing the dielectric member from the antenna module and is substantially parallel to the plate, and the conductive member may have a second width in the second direction, which is larger than the first width.

In an embodiment, the conductive member may be grounded through, except for the antenna module, another component in the portable communication device.

While the disclosure has been shown and described with reference to various embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the disclosure as defined by the appended claims and their equivalent.

What is claimed is:

1. A portable communication device comprising:
- a display defining a front surface of the portable communication device;
- a plate defining a rear surface of the portable communication device and comprising a nonconductive material, wherein the plate is configured to have a first surface facing an outside of the portable communication device and a second surface facing an inside of the portable communication device;
- a first antenna module attached to a first area of the second surface or disposed adjacent to the first area;
- a second antenna module attached to a second area of the second surface or disposed adjacent to the second area; and
- a conductive member disposed in or attached to a third area between the first area and the second area,
- wherein the conductive member at least partially interrupts some electric waves, among electric waves radiated from the first antenna module, that travel towards the second antenna module through the plate.

2. The portable communication device of claim **1**,
- wherein the first antenna module has a first width in a second direction that is substantially perpendicular to a first direction facing the second antenna module from the first antenna module and is substantially parallel to the rear surface, and
- wherein the conductive member has a second width in the second direction, the second width being greater than the first width.

3. The portable communication device of claim **1**, wherein the conductive member is grounded through, except for the first antenna module and the second antenna module, another component in the portable communication device.

4. The portable communication device of claim **3**, wherein the other component comprises a bracket at least partially supporting the plate or the display, and the conductive member is electrically connected to a ground of the bracket.

5. The portable communication device of claim **1**, wherein the conductive member is spaced apart from the first antenna module by a first distance and is spaced apart from the second antenna module by a second distance which is greater than the first distance.

6. The portable communication device of claim **1**, wherein the conductive member is deposited in the third area.

7. The portable communication device of claim **1**, further comprising:
- a film disposed between the third area and the conductive member; and
- a bonding layer disposed between the third area and the film.

8. The portable communication device of claim **1**, wherein the plate comprises glass.

9. The portable communication device of claim **1**,
- wherein the first antenna module comprises a first printed circuit board and a first antenna disposed in the first printed circuit board, and
- wherein the second antenna module comprises a second printed circuit board and a second antenna disposed in the second printed circuit board.

10. The portable communication device of claim **9**, wherein the second antenna comprises a coil configured to support near field communication (NFC).

11. The portable communication device of claim **9**, wherein the second antenna module comprises a nonconductive member disposed between the plate and the second printed circuit board.

12. A portable communication device comprising:
- a display defining a front surface of the portable communication device;
- a plate defining a rear surface of the portable communication device and comprising a nonconductive material, wherein the plate is configured to have a first surface facing an outside of the portable communication device and a second surface facing an inside of the portable communication device;
- an antenna disposed in or attached to a first area of the second surface or disposed adjacent to the first area;
- an electronic component disposed in or attached to a second area of the second surface; and
- a conductive member mounted on a third area of the second surface of the plate,
- wherein the third area is between the first area and the second area, and
- wherein the conductive member at least partially interrupts some electric waves, among electric waves radiated from the antenna, that travel toward the electronic component through the plate.

13. The portable communication device of claim **12**,
- wherein the antenna has a first width in a second direction that is substantially perpendicular to a first direction facing the electronic component from the antenna and is substantially parallel to the rear surface, and
- wherein the conductive member has a second width in the second direction, the second width being greater than the first width.

14. The portable communication device of claim **12**, wherein the conductive member is spaced apart from the antenna by a first distance, and is spaced apart from the electronic component by a second distance which is greater than the first distance.

15. The portable communication device of claim **12**, further comprising:

a film disposed between the third area and the conductive member; and

a bonding layer disposed between the third area and the film.

16. The portable communication device of claim **12**, further comprising:

a first printed circuit board, in which the antenna is disposed,

wherein the electronic component comprises a second printed circuit board and a second antenna disposed in the second printed circuit board.

17. The portable communication device of claim **16**, further comprising:

a shield member disposed adjacent to the antenna,

wherein the shield member comprises a conductive pattern, which opens in a first direction facing the second antenna from the antenna, at least a portion of the conductive pattern being disposed in a second direction which is different from the first direction.

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